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THE FORMAL OPENING OF THE LABORATORY OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH.[1]

A SKETCH OF THE DEVELOPMENT OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH.

FIVE years ago there were in France, Germany, England, Russia and Japan well-equipped and endowed institutions for research in medicine. In this country not one existed. For pure and applied science, all our higher institutions of learning had their laboratories, their corps of instructors and fellowships, and both opportunity and encouragement were given to students to take up original work. But how great the contrast when we turn to medicine, whose problems are related not only to the health but even the life of the race. The poverty of the resources of the medical institutions was truly pitiful. Their laboratories were for the instruction of students and possessed but little equipment beyond what was necessary for this end.

It was at this time that a group of five men met in the Arlington Hotel at Washington just five years ago last week, at the request of the founder of this institute, to consider the question of the establishment of an institution to promote research in medicine. There could be but one opinion, and, at the conference only one was expressed, *viz.*, That the most urgent need existed and that the time was ripe for the foundation of such an institution in this country.

[1] May 11, 1906.

Never was a suggestion more warmly welcomed nor an offer more heartily appreciated by the profession and the medical press from one end of the country to the other.

To this group of five, two others were added a few weeks later, and on June 14, 1901, the institution was formally incorporated as The Rockefeller Institute for Medical Research, with the seven men referred to as its board of directors. They were William H. Welch, T. Mitchell Prudden, Christian A. Herter, Theobald Smith, Hermann M. Biggs, Simon Flexner and L. Emmett Holt. The same board has been continued up to the present time. At this first meeting a pledge of $200,000 was made to the board to be drawn upon at their discretion during a period of ten years, it being understood that this was for preliminary work.

In considering what use should be made of the funds placed at its disposal to make them immediately productive of some scientific results, and at the same time to get a general view of the field, the board decided not to centralize work in a single place, but to create a number of scholarships or fellowships to be distributed in existing laboratories throughout the country. In this way it was hoped several ends might be attained: first, to enlist the cooperation of various investigators in different places; secondly, to aid some promising lines of research which could not be continued for lack of funds; and, finally, to discover who and where were the persons who desired to undertake research work and what were their qualifications.

From a large number of applications received, twenty-three grants were made to eighteen different laboratories in this country, and three men were sent abroad to pursue special investigations, two in Ehrlich's laboratory in Frankfurt and one in Koch's Institute in Berlin.

At the end of the first year's work, it was evident to the directors that while much could be accomplished by individual workers carrying on their investigations in separate laboratories, widely scattered, the highest results in research could not be secured in this manner. Existing institutions did not afford adequate facilities for many phases of investigation which were of the greatest importance. Again, the heads of these institutions, although in many instances men of great ability, were so taken up with their duties as teachers as to leave comparatively little of either time or energy to devote to research work. It was gratifying to find that there were a large number of earnest men and women in America anxious to devote themselves to this branch of science; but it was quite clear that very few possessed the breadth of education combined with the technical training requisite for independent work. The directors, therefore, were united in the conviction that, although many important investigations might be fostered by continuing the plan of foreign grants, great progress was not possible in this way, and that this could be secured only by centralizing the most important lines of work in a fixed place, under a competent head or series of heads, and with special equipment. In other words, the institute must have a laboratory of its own with its own staff of workers who should devote their entire time to research.

These conclusions and the considerations upon which they were based were, therefore, placed before the founder, who at the second annual meeting, in June, 1902, made another and larger gift to the institute, to enable the board of directors to acquire land and erect a laboratory building in which to begin the work of organization along the broader lines contemplated.

The first question to be decided was where such an institute should be located.

After due consideration of the advantages offered in other cities, New York was unanimously selected as possessing greater advantages than were elsewhere to be found in America. The next step was to find a suitable site; one which should be adequate, not only to present needs, but for future expansion; near enough to the center of the city to be accessible, and yet sufficiently removed to secure for its workers the freedom from needless interruptions and the quiet necessary for scientific pursuits.

After a prolonged search, the committee on site reported in October, 1902, in favor of the Schermerhorn property, fronting East River at East 66th and 67th Streets, as meeting to a remarkable degree all the requirements. This entire property was purchased by Mr. Rockefeller a few months later, and a plot comprising twenty-six and a half city lots, upon which the present building stands, was deeded to the institute. Work was immediately begun upon plans for a laboratory building.

The next great question was the choice of a scientific director. After looking over the entire field in America and Europe, the board could find no one possessing the qualifications to so high a degree as one of its own members, Dr. Simon Flexner, who was prevailed upon to resign his position as professor of pathology in the University of Pennsylvania, and assume the directorship of the scientific work in the new laboratory. Dr. Flexner began his work July 1, 1903, and spent the following year in Europe, studying various questions connected with institutions for research, especially those of organization, construction and equipment. He also acquired the nucleus of a library for the institute.

Eighteen months and much careful thought were spent in completing the plans for the present laboratory building. During this time five of the directors visited Europe, in order to profit by the experience of other institutions of a similar character. Final plans were adopted June 13, 1904; and a few weeks later contracts were let, ground was broken for the new building and December 3 of the same year the cornerstone was laid.

It was quite clear to the directors that it was unwise to delay commencing work until the new laboratory was completed. It was decided to take steps at once to get together a nucleus of a future laboratory staff; that it was best that a beginning should be made with a small program, a few problems, in a small building, so that the institute should be in a position for a natural organic growth and development and avoid the dangers incident to rapid expansion. A building at the corner of Lexington Avenue and 50th Street was leased and fitted up for temporary use. In that place, in October, 1904, work was begun and continued for eighteen months until the completion of the new building a few weeks ago.

The staff at first consisted only of the director and four other workers. It has, however, been gradually increased until, at the time of removal, it numbered nine persons.

One of the most difficult problems presented to the board has been to secure a staff of scientific workers. Heads of laboratories and their assistants in this country are, almost without exception, men trained for the work of instruction rather than that of investigation. Many applications for positions in the institute have been received from England, France and Germany, but the feeling of the directors has been that it was the American type of mind, with its genius for practical results, that was wanted, and this has made the board doubtful as to the wisdom of choosing European heads for any of its departments. Many young men and women

were found in this country with evident capacity, yet few possessed necessary training which should fit them to work independently. With each year's experience the conviction has steadily grown that the institute must in large measure train its own staff, selecting from the promising young applicants such as gave evidence of a special fitness and giving them subsequently such training both here and abroad as would fit them for their special work.

To get in close touch with such a class, a number of resident scholarships and fellowships have been created. For these thirty-one applications were received during the present year and five have been awarded. This plan, if successful, will be continued and from this corps, from time to time, will be recruited the future workers of the institute.

The present organization provides for the following departments: pathology, bacteriology, physiological and pathological chemistry, physiology, comparative zoology. To these it is expected that a department of pharmacology and experimental therapeutics will soon be added.

The fully organized staff will consist of a chief director and a head for each of the different departments. Each head will have his associate and corps of assistants. The heads of departments, associates and first assistants, it is expected, will constitute the permanent staff of the institute. The other workers will be less closely attached. Besides, there are contemplated scholarships and fellowships for workers who may come for a limited period; and finally, it is expected to provide for a limited number of voluntary workers who will be given the facilities of the institute for working out, under supervision, their own problems.

While the purpose of the institute will be research, not instruction, it can not fail to exert a considerable influence in medical education, since many of those who will receive their training within its walls will, doubtless, go elsewhere to assume positions of responsibility in teaching institutions.

The present scientific staff consists of fourteen persons; the laboratory building, when fully equipped, will furnish facilities for about fifty workers.

Much work must always be done in the fundamental subjects of chemistry, biology, physiology and pathology, for upon these basic sciences future discoveries in medical science must largely rest. While fully realizing the importance of these and liberally providing for them in its laboratory, the institute aims at the same time to keep close to the practical side, and will endeavor to apply the latest discoveries in science to problems connected with the prevention and cure of disease. In order that the greatest good can be accomplished along these lines, the board realizes that a hospital closely affiliated with the institute is indispensable. Only in this way is it possible for those who work in the laboratory to appreciate the relation of their results to the problems of practical medicine. The hospital need not be large, but should be fully equipped. Such a hospital it is hoped may soon be added to the institute, in which the closest kind of scientific study may be given to obscure diseased conditions.

From the very beginning, the institute has sought not to monopolize the field, but to cooperate in all possible ways with existing agencies for medical research in this country. It has cooperated with the Health Department of New York in the study of the conditions surrounding the production and distribution of the milk supply of the city, and the effects of milk upon the health of the children in the tenements; also with the commission appointed by the city in 1904, to study the prevalence of the acute respiratory diseases, and with that appointed in 1905 to investigate cerebro-spinal

meningitis. It has united with Harvard University in sending a man to Manila to study certain phases of smallpox. With the same end in view, also, it has made grants each year to assist important investigations which were being carried on in various places.

While it has been impossible to aid more than a small proportion of the even suitable ones asking for assistance, still an average of twenty grants has been made each year, and much excellent work done which otherwise could not have been undertaken.

With the opening of a central laboratory for research in New York, these foreign grants will necessarily become a less important part of the work. It is not, however, the intention of the institute to discontinue them altogether. The board hopes always to be ready, with a grant of money or by sending a trained man, to assist in the solution of any important emergency problem which may arise in connection with the public health in any part of the country.

The work done entirely or in part under the auspices of the institute and published in various scientific journals has been collected in volumes of reprints; four such volumes of about five hundred pages each having already been issued, two in 1904 and two in 1905; a fifth volume is now in press. The need of a special organ of publication was early felt by the board and in 1904 negotiations were opened with the editor of the *Journal of Experimental Medicine* with a view to transferring its control to the institute. This has been accomplished.

In February, 1905, the institute took charge of the publication of this journal, under whose auspices it has since been issued. In it are published not only the work of the institute, but also other scientific contributions of a similar nature.

In the five volumes of reprints appear 137 original papers; they may be classified under the following heads: There were 50 papers relating to etiology, or the causation of disease; 28 relating to pathology; 12 to bacteriology; 22 to physiology; 8 to chemistry; 9 to toxicology; 7 to experimental therapeutics, and 1 to pathological anatomy.

Among the most important researches in point of the attention which has been given to them may be mentioned: 21 papers upon dysentery and diarrhœal diseases; 5 papers upon milk; 4 papers upon smallpox; 12 upon various pathological conditions of the blood; 3 upon diabetes; 5 upon trypanosomiasis, and 6 upon snake venom. The other topics are widely distributed over the field of scientific medicine.

To many, five years may seem a long time to be taken up with the work of preliminary organization. Many difficulties have been encountered and many perplexing questions have come up for decision. It has been the policy of the board of directors to proceed deliberately, and no step has been taken until a conviction regarding the wisdom of it was practically unanimous.

To outline the development of an institution which should secure the highest possible efficiency has been no easy task. European models have aided greatly, but it was believed that what was needed in America was an institution different in many important respects from those of Europe. While many years will be required for the full development of the institute, the board has felt that the general policy should be reflected from the outset. Throughout it has striven to keep constantly in mind the intention of the founder, expressed in his letter of gift, that the trust was to be administered in such a way as 'to accomplish the most for humanity and science.'

The present staff of the institute is composed of the following persons:

Department of Pathology and Bacteriology—Dr. Simon Flexner, Dr. E. L. Opie, Dr. H. Noguchi, Dr. J. E. Sweet, Dr. H. S. Houghton.

Department of Physiology—Dr. S. J. Meltzer, Dr. John Auer.

Department of Chemistry—Dr. P. A. Levene, Dr. W. Beatty.

Resident Fellows and Scholars—B. F. Terry, zoology; R. D. MacLaurin, chemistry; Chas. A. Rouiller, chemistry; E. H. Schorer, bacteriology; Bertha I. Barker, bacteriology.

L. Emmett Holt.

THE ENDOWMENT OF RESEARCH.

The support of hospitals has always made a strong appeal to the philanthropy of the state and of individual citizens, and the importance to the community of educated physicians has been appreciated, although in this country until recent years most inadequately, but the recognition of medical science as a rewarding object of public and private endowment is almost wholly the result of discoveries in this department of knowledge made during the last quarter of a century. An eloquent witness to the awakening of this enlightened and beneficent sentiment is the establishment, in 1901, of the Rockefeller Institute for Medical Research with its laboratories formally opened to-day.

While the scientific study of infectious diseases is, of course, not of recent origin and had been pursued as a part of the functions of health departments and of university laboratories of hygiene and of pathology, the first provision of a special laboratory for this purpose was made by the German government in 1880, in the Imperial Health Office in Berlin, and to the directorship of this laboratory was called from his country practise Robert Koch, who four years before had startled the scientific world by his memorable investigations of anthrax.

The supremacy of Germany in science is due above all to its laboratories, and no more fruitful record of scientific discoveries within the same space of time can be found than that afforded by this laboratory during Koch's connection with it, from 1880 to 1885. Thence issued in rapid succession, the description of those technical procedures which constitute the foundation of practical bacteriology and have been the chief instruments of all subsequent discoveries in this field, the determination of correct principles and methods of disinfection, and the announcement of such epochal discoveries as the causative germs of tuberculosis—doubtless the greatest discovery in this domain—of typhoid fever, diphtheria, cholera, with careful study of their properties.

The leading representative, however, of the independent laboratory devoted to medical science is the Pasteur Institute in Paris, founded in 1886, and opened in 1888. The circumstances which led to the foundation of this institute made probably a stronger appeal to popular sympathy and support than any others which have ever occurred in the history of medicine.

There stood in the first place, the personality and the work of that great genius, Louis Pasteur, of noble and lovable character, one of the greatest benefactors of his kind the world has known, who for forty years had been engaged, often under adverse conditions, in investigations which combined the highest scientific interest with important industrial and humanitarian applications. Pasteur's revelation of the world of microscopic organisms in our environment—the air, the water and the soil—and his demonstration of their relation to the processes of fermentation and putrefaction, had led Lister in the late sixties, even before anything was definitely known of the causative agency of bacteria in human diseases, to make the first and most

important application of bacteriology to the prevention of disease by the introduction of the principles of antiseptic surgery, whereby untold thousands of human lives have been saved.

In 1880, came the most momentous of Pasteur's contributions to medical science and art in the introduction of the method of active immunization by the use of the living parasites of the disease attenuated in virulence, a method which until this date had remained without further application since its employment by Edward Jenner in 1796 in vaccinating against smallpox. Pasteur's researches in this field of immunity, marvelous in their originality, ingenuity and fertility of resource, culminated in 1885 in the announcement of his successful method of protective inoculation against that dread disease, rabies, and most of those here present will recall the enthusiasm with which this great triumph of experimental medicine was hailed throughout the civilized world.

It was under the immediate impression and the incentive of this discovery, and as a mark of gratitude to Pasteur, that over two and one half million francs were raised within a short time by international subscription for the construction and endowment of an institute to bear his name, where the Pasteur treatment was to be carried out and ample facilities afforded for investigations of microorganisms and the problems of infectious diseases. This model institute, much enlarged since its foundation and after the death of Pasteur under the directorship, first of Duclaux, and now of Roux, and in one of its most important divisions, of Metchnikoff, has been a fruitful center of productive research and through its contributions to knowledge affords a signal illustration of the benefits to science and to humanity of the endowment of laboratories for the advancement of medical science.

It was under much the same influences that the important Imperial Institute for Experimental Medicine in St. Petersburg, with even wider scope than the Pasteur Institute, was founded and munificently endowed by Prince Alexander of Oldenburg in 1890.

In the following year the Prussian government established in Berlin, under the directorship of Professor Koch, the admirably organized and equipped Institute for Infectious Diseases, to which is attached, as to the Pasteur Institute, a hospital for infectious diseases. This and the excellent Institute for Experimental Therapeutics, in Frankfort, under Professor Ehrlich's direction, founded also by the Prussian government in 1896, are unsurpassed in their scientific activities and in the number and value of their contributions to our knowledge of infection and immunity.

In 1891, was founded in London the British, later the Jenner, and now the Lister, Institute of Preventive Medicine, designed to be a national institute similar in character and purpose to the Institut Pasteur, in Paris. The funds were contributed by the public, and subsequently increased by Lord Iveagh's generous gift of two hundred and fifty thousand pounds.

Within less than a year after the foundation of the Rockefeller Institute for Medical Research, the Memorial Institute for Infectious Diseases was founded in Chicago, by Mr. and Mrs. Harold F. McCormick, and placed under the capable direction of Professor Hektoen.

The Institute for the Study, Treatment and Prevention of Tuberculosis, which bears the name of its beneficent founder, Henry Phipps, was incorporated in Philadelphia in 1903, and, while devoted to a single disease, it must be ranked among those of wide scope, when we consider the magnitude and surpassing importance of

the problems pertaining to this disease.

It may also be noted that the Carnegie Institution in Washington, with its unequaled endowment of ten million dollars, includes within its scope the support of biological and chemical investigations of great importance to medical science, so that our country now stands in line with Germany, France and Great Britain in the opportunities afforded for research in medical and other sciences.

These various institutions have been mentioned as typifying the general aims and character of the Rockefeller Institute for Medical Research, rather than to afford any complete picture of the material aid now available for the advancement of scientific medicine. If the latter were the purpose, it would be necessary to travel far afield so as to include independent medical laboratories of more restricted scope, such as those for the study of cancer, the laboratories connected with departments of health, so well exemplified in our own country by those of the state board of health of Massachusetts, and of the department of health of the city of New York, hospitals and the laboratories connected with them, the medical laboratories of the universities and medical schools, such as the Thompson Yates and Johnston laboratories in Liverpool, and the splendid new laboratories of the Harvard Medical School, laboratories established in recent years for the study of tropical diseases, such as our government laboratories in Manila, and funds available for special grants to investigators.

Impressive and encouraging as is this remarkable growth within recent years of laboratories devoted to the medical sciences, no one who has any knowledge of the vast field to be covered, of the difficulty and complexity of the problems, of the expenditure of money required, and of the returns in increased knowledge and benefits to mankind which have been attained and which may be expected in increasing measure, can for a moment suppose that the existing opportunities, considerable as they are, are adequate to meet the present and the future needs of scientific medicine.

As I have already stated, the wider recognition of medical science as a rewarding object of endowment is a result of discoveries made during the last quarter of a century, and it is of interest to inquire why this increased knowledge should have borne such abundant fruit. The result is not due to any change in the ultimate aims of medicine, which have always been what they are to-day and will remain, the prevention and the cure of disease, nor to the application to the solution of medical problems of any higher intellectual ability and skill, than were possessed by physicians of past generations, nor to the growth of the scientific spirit, nor to the mere fact of a great scientific advance in medicine, for the most important contribution ever made to our understanding of the processes of disease was the discovery by Virchow, in the middle of the last century, of the principles and facts of cellular pathology, the foundation of modern pathology.

The awakening of this wider public interest in scientific medicine is attributable mainly to the opening of new paths of investigation which have led to a deeper and more helpful insight into the nature and the modes of prevention of a group of diseases—the infectious diseases—which stand in a more definite and intimate relation to the social, moral and physical well-being of mankind than any other class of diseases. The problems of infection which have been solved, and kindred ones which give promise of solution, are among the most important relating to human society. The dangers arising from the spread of contagious and other infectious diseases, threaten, not the individual only, but in-

dustrial life and the whole fabric of modern society. Not medicine only, but all the forces of society are needed to combat these dangers, and the agencies which furnish the knowledge and the weapons for this warfare, are among the most powerful for the improvement of human society.

Great as was the material, intellectual and social progress of the world during the past century, there is no advance which compares in its influence upon the happiness of mankind with the increased power to lessen physical suffering from disease and accident, and to control the spread of pestilential diseases. Were we to-day as helpless as the physicians of past centuries in the face of plague, smallpox, typhus fever, cholera, yellow fever and other epidemic diseases, even if the existence of our modern crowded cities were possible, which may be doubted, the people would sit continually in the shadow of death. Great industrial activities of modern times, efforts to colonize and to reclaim for civilization vast tropical regions, the immense undertaking to construct the Panama Canal, are all in the first instance dependent upon the successful application to sanitary problems of knowledge, much of it gained in recent years, concerning the causation and propagation of epidemic and endemic diseases.

And yet probably a fair measure of the general realization of these facts is the provision by Congress that of the seven members of the Isthmian Canal Commission, four shall be engineers without a word concerning a sanitarian on the commission. There could hardly be a more impressive opportunity to demonstrate to the world the practical value of our new knowledge concerning the mode of conveyance of malaria and yellow fever, the two great scourges of Panama, than that afforded by the digging of the Isthmian Canal. The sanitary problem is not surpassed in difficulty by the engineering problem, but we may feel reasonable assurance that with the sanitary control in hands as trained and capable as those of Colonel Gorgas, the ghastly experiences of the old French Panama Canal Company and in the construction of the railway will not be repeated.

To comprehend fully the degree and the character of the progress of modern medicine requires a kind of knowledge and a breadth of vision not possessed by the average man. He is concerned mainly with the prompt relief of his own ailments or those of his family. Of the triumphs of preventive medicine he knows little or nothing. With such dull matters as the decline in the death rate by one half, and the increase in the expectation of life by ten or twelve years during the last century, he does not concern himself. He takes no account of the many perils which have been removed from his pathway since his birth, and indeed at the time of his birth, nor does he know that had he lived a little over a century ago and survived these perils, he would probably be marked with smallpox.

While it is true that in the relief of physical suffering and in the treatment of disease and accident the progress has been great and the physician and the surgeon can do more, far more to-day than was possible to his predecessors, and while improvement in this direction must always be a chief aim of medicine, still it is in the prevention of disease that the most brilliant advances have been made. The one line of progress, that with which the daily work of the physician is concerned, affects the individual, the unit; the other, like all the greater movements in evolution, affects the race. It has been argued, with a certain measure of plausibility, that the interference with the law of the survival of the fittest, assumed to be a result of the

success of preventive medicine, will bring about deterioration of the race. I believe the argument to be fallacious, and that we already have sufficient experience to show that there need be no serious apprehension of such a result.

Before some accurate knowledge of the causation of infectious diseases was secured, preventive medicine was a blundering science, not, however, without its one great victory of vaccination against smallpox, whereby one of the greatest scourges of mankind can be controlled and could be eradicated, if the measure were universally and efficiently applied. The establishment upon a firm foundation of the germ doctrine of infectious diseases, the discovery of the parasitic organisms of many of these diseases, the determination by experiment of the mode of spread of certain others, and the experimental studies of infection and immunity, have transformed the face of modern medicine. The recognition, the forecasting, the comprehension of the symptoms and lesions, the treatment of a large number of infectious diseases, have all been illuminated and furthered, but the boon of supreme import to the human race has been the lesson that these diseases are preventable.

Typhus fever, once wide-spread, and of all diseases the most dependent upon filth and overcrowding, has fled to obscure, unsanitary corners of the world before the face of modern sanitation.

In consequence of the knowledge gained by Robert Koch and his coworkers, Asiatic cholera, to the modern world the great representative of a devastating epidemic, will never again pursue its periodical, pandemic journey around the world, even should it make a start.

Of bubonic plague, the most dreaded of all pestilences, which disappeared mysteriously from the civilized world over two centuries ago, we know the germ and the manner of propagation, and, although it has ravaged India for the last ten years with appalling severity, it can be and has been arrested in its spread when suitable measures of prevention are promptly applied.

Typhoid fever, the most important index of the general sanitary conditions of towns and cities, has been made practically to disappear from a number of cities where it formerly prevailed. That this disease is still so prevalent in many rural and urban districts of this country, is due to a disgraceful neglect of well-known measures of sanitation.

To Major Walter Reed and his colleagues of the army commission, this country and our neighbors to the south owe an inestimable debt of gratitude for the discovery of the mode of conveyance of yellow fever by a species of mosquito. On the basis of this knowledge, the disease, which has been long such a menace to lives and commercial interests in our southern states, has been eradicated from Cuba, and can be controlled elsewhere.

Another army surgeon, Major Ross, acting upon the suggestion of Sir Patrick Manson, had previously demonstrated a similar mode of incubation and transportation of the parasite of malaria, discovered by Laveran, and it is now possible to attack intelligently and in many localities, as has already been proven, with good promise of success, the serious problem of checking or even eradicating a disease which renders many parts of the world almost uninhabitable by the Caucasian race and, even where less severe, hinders, as does no other disease, intellectual and industrial activities of the inhabitants. It is gratifying that one of our countrymen and a member of the board of directors of this institute, Dr. Theobald Smith, by his investigations of Texas cattle fever, led the way in

the discovery of the propagation of this class of disease through an insect host.

The deepest impress which has been made upon the average death rate of cities has been in the reduction of infant mortality through a better understanding of its causes. The Rockefeller Institute, by the investigations which it has supported of the questions of clean milk and of the causes of the summer diarrhœas of infants, has already made important contributions to this subject, which have borne good fruit in this city and elsewhere.

No outcome of the modern science of bacteriology has made a more profound impression upon the medical profession and the public, or comes into closer relation to medical practise than Behring's discovery of the treatment of diphtheria by antitoxic serum, whereby in the last twelve years the mortality from this disease has been reduced to nearly one fifth of the former rate.

The most stupendous task to which the medical profession has ever put its hands is the crusade against tuberculosis, whose preeminence as the leading cause of death in all communities is already threatened. Sufficient knowledge of the causation and mode of spread of this disease has been gained within the last quarter of a century, to bring within the possible bounds of realization the hopes of even the most enthusiastic, but it will require a long time, much patience and a combination of all the forces of society, medical, legislative, educational, philanthropic, sociological, to attain this goal.

Time forbids further rehearsal, even in this meager and fragmentary fashion, of the victories of preventive medicine. Enough has been said to make clear that man's power over disease has been greatly increased in these latter days. But great and rapid as the progress has been, it is small in comparison with what remains to be done. The new fields which have been opened have been explored only in relatively small part. There still remain important infectious diseases whose secrets have not been unlocked. Even with some whose causative agents are known, notably pneumonia and other acute respiratory affections, and epidemic meningitis, very little has yet been achieved by way of prevention. The domain of artificial immunity and of the treatment of infections by specific sera and vaccines, so auspiciously opened by Pasteur and by Behring, is still full of difficult problems, the solution of which may be of immense service in the warfare against disease. Of the cause of cancer and other malignant tumors nothing is known, although many workers with considerable resources at their disposal are engaged in its study. With the change in the incidence of disease, due at least in large part to the repression of the infections of early life, increased importance attaches to the study of the circulatory, renal and nervous diseases of later life, of whose underlying causes we are very imperfectly informed. There are and will arise medical problems enough of supreme importance to inspire workers for generations to come and to make demands upon all available resources.

In directing attention, as I have done, to some of the practical results of scientific discovery in medicine, and in indicating certain of the important problems awaiting solution, there is always the danger of giving to those unfamiliar with the methods and history of such discovery a false impression of the way in which progress in scientific knowledge has been secured and is to be expected. The final victory is rarely the result of an immediate and direct onslaught upon the position ultimately secured. The advance has been by many and devious and gradual steps, leading often, it might appear, in quite different

directions, and mounted more frequently than not to secure a wider prospect, but without any thought of the final goal. The army contains a multitude of recruits drawn from the most various fields, the biologist, the chemist, the physiologist contributing their share to medical triumphs just as truly as the pathologist, the bacteriologist, the hygienist, the clinician. The inspiration has been the search for truth and joy in the search far more than any utilitarian motive. In the fullness of time comes the great achievement; the leader is hailed, but he stands upon the shoulders of a multitude of predecessors whose contributions to the result are often lost from view.

In full recognition of the dependence of success in the warfare with disease upon increase of knowledge, the Rockefeller Institute for Medical Research was founded by the enlightened munificence of Mr. John D. Rockefeller, to whom we make grateful acknowledgment. Likewise to the broad sympathies and active interest of his son, Mr. John D. Rockefeller, Jr., the origin and development of this institution are largely indebted.

What has already been accomplished, as well as the general scope and aims of the institute, have just been concisely indicated to you by Dr. Holt. My purpose has been to show, although of necessity most inadequately, that these aims relate to matters of the highest significance to human society, that the present state of medical science and art requires large resources for its advancement, and that the returns in benefits to mankind have been and will continue to be great out of all proportion to the money expended.

May the hopes of the founder and of those who have planned this institute be abundantly fulfilled! May it contribute largely to the advancement of knowledge, and may the streams of knowledge which flow from it be 'for the healing of the nations.'

William H. Welch.

It seems to me significant that this home of scientific research is placed amid the teeming population of a great city. Science has for its end service, and there will be no quicker or more useful application of the discoveries made here than among the tens of thousands who live just outside these walls.

In no way has knowledge more completely revealed its power than in the triumphs of modern engineering and of modern medicine. Engineering and medicine have conspired together to make human life pleasanter and happier, and to relieve it from a large amount of suffering and pain. The transmission of energy over long distances and in new forms and the discoveries of the modern pathologists have changed the conditions and even the aspect of life more than we realize.

These buildings are dedicated to the relief of human disease and human suffering by the application of scientific method to the study of a concrete body of facts. They will exert their influence in three ways: they will add to the sum total of human knowledge in respect to medicine; they will aid in developing a company of trained scientific observers; and they will help spread abroad in the public mind a respect for science and for scientific method. Each of these services is a public service, but the last named is perhaps the greatest.

Pasteur, whose name will often be spoken here and always with reverence, understood this. In 1870, when his country was crushed under overwhelming disaster and staggering under blow upon blow, he found voice to say that neglect of science and of scientific research was a powerful cause of

the moral and the military humiliation of France. Said Pasteur:

> France has done nothing to keep up, to propagate and to develop the progress of science in our country. * * * She has lived on her past, thinking herself great by the scientific discoveries to which she owed her material prosperity, but not perceiving that she was imprudently allowing the sources of those discoveries to become dry. * * * While Germany was multiplying her universities, establishing between them the most salutary emulation, bestowing honors and consideration on the masters and doctors, creating vast laboratories amply supplied with the most perfect instruments, France enervated by evolutions, ever seeking vainly for the best form of government, was giving but careless attention to her establishments for higher education.

Each year shows more clearly how true this view is, and how fully it applies to the triumphs both of peace and of war. Japan has even more profoundly impressed the world by her knowledge of scientific fact and by her rigid application of that knowledge than by the valor and military skill of her soldiers and sailors. No people are more in need than our own of learning the all-important lesson that the modern Germans and the modern Japanese have to teach. Respect for the man who knows and loyalty to demonstrated truth are characteristics of civilization that is founded on rock. Our American happy-go-lucky, wasteful way of approaching a serious problem, our naïve egotism and our exaltation of the man who does things, no matter how, must sooner or later give way to more patient study, to more respect for the experience and wisdom of other countries than our own, and to more regard for correctness and sound principle, than for a superficial costly 'efficiency,' if we are to hold the place in the world's esteem for which we are rightfully ambitious.

This institution is to be welcomed, then, not alone for what it will do for medicine, and not alone for what it will do indirectly for the relief of suffering human beings. It is to be welcomed still more for the lessons it will teach to our public opinion; for the guidance it will offer toward a juster appreciation of the relations between theory and practise, between observation and reasoning; and for the assurance it affords that generous support is to be had in this dear country of ours from men of affairs for research of the highest and most severe type.

Of the subjects with which the institute is to deal, when we reflect upon their variety, their far-reaching importance and their manifold relationships, can we say less than Faraday once wrote to Tyndall:

> Our subjects are so glorious that to work at them rejoices and encourages the feeblest, delights and enchants the strongest.

NICHOLAS MURRAY BUTLER.

THE educated public needs to obtain a clearer idea than it now has of scientific research, of its objects and results, and of the character and capacity of the men who devote themselves to it. The educated classes have a tolerably accurate conception of research in such subjects as history including antiquities, economics, philology, law and government; for research in these subjects relates chiefly to the past, remote or near. The public has also been long interested in the inventor's resourceful and persevering habit of mind—the inventor who is trying to make some new application of acquired knowledge, or to discover a new fact or principle which can be put to commercial use. But scientific research is somewhat different from these other kinds of research. It has deep roots in the past; but its object is never to demonstrate merely what has been done or said, or to obtain a monopolistic profit. Invariably its object is to extend the boundaries of knowledge, and to win new power over nature. It is not chiefly concerned to enlarge records of the past, or to make them

more accurate, but rather to use all the powers the past has conferred on the human spirit to win new power. The past gives the scientific investigator his lever and the present his fulcrum; but his work is to take effect on the future, and is to give him or his successors a stronger lever and a better placed fulcrum. As a rule, scientific research is carried on with no public observation, and as silently as nature elaborates and throws out the mantling verdure of spring; but on an exceptional occasion like this, and in a country which has already reaped great benefits from the endowment of institutions of education and charity by public-spirited persons, it is fitting that the beneficent work of the scientific investigator should be accurately described, and commended to the favor of an enlightened public opinion.

Let us first consider what mental habits and powers the scientific investigator needs to have acquired and to keep in exercise, or in other words what sort of a mind the investigator ought to have. In the first place, he needs the faculty and the habit of determining and grasping facts, and then verifying and digesting them. He must next be capable of conceiving hypotheses which will connect his facts, or explanations that will group them or arrange them in a series. These hypotheses or explanations will come to him as results of reflection or of imaginative scheming; in the common phrase, ideas will occur to him. A preconceived idea may be a great power in experimental researches; but the inquirer must have the habit of pursuing to verification or disproof all such ideas. He must test them by new experiments contrived for that purpose. He must exhaust all the adverse hypotheses which come to his mind. He must always keep in the road that leads to truth, although he does not know just where the truth lies. If through the play of his imagination he gets off the right road, his rigorous experimentation must bring him back to the safe path of the inductive method. He must possess patience and reserve, but also enthusiasm and a capacity for eager speculation. Science has often profited by a suggestive theory, which was far from being true. Indeed, the history of scientific progress is full of these profitable theories, which have been abandoned one after the other; and in all probability the series of such theories will prove to be infinite. Sometimes theories long forgotten are taken up again after the defeat of the later theories which caused the forgetting of the earlier. However it may be in theology, it is quite certain that in science there is as yet no such thing as final truth. Accordingly, investigators in any science need an unusual perspicacity or clear-sightedness in regard to its theories; they need, each in his own field, a full knowledge of the work already done, and a clear perception of the bearings of the most recent discoveries. This perspicacity is in some measure a natural gift; but it is also a faculty capable of a high degree of training. It sees clearly the approximate truth already discovered, and goes forward to obtain a closer approximation.

The general features of scientific research are similar in all fields, although each kind has its peculiar difficulties. The field of the individual inquirer need not necessarily be wide; although the progress of many sciences is often contributory to the progress of one, and that investigator has a great advantage who is capable of seeing clearly the bearings of new discoveries in kindred sciences on the particular inquiry he has in hand. It is all-important, however, in all fields, that the investigator should be capable of seizing on the essential parts of the inquiry—that is, on

its causative elements, rather than on those parts which relate to identification, classification and nomenclature. The pioneers of science, like the pioneers in exploration and colonization, must find their way through pathless regions. It is only later generations that build smooth roads and railways for the transportation of inattentive multitudes where the pioneer trod alone and watchful. The investigator must be watchful over minor details and for apparently insignificant differences and similitudes. He must know how to find his clues in trifling circumstances and illusive changes of condition. In these days of germs and spores, when micro-organisms have been proved to be infinitely important in the economy of nature, the investigator, and especially the biologist, will probably have a peculiar conception of the great and the small, or the gross and the minute. The infinitely little may often seem to him of highest importance, his scale of values having no connection with spacial magnitude or gravity. On the other hand, the investigator must be keen to discern relationships among facts—first among facts easily classed as kindred, but then among facts which to the common mind are unconnected or disconnected. The intellectual tastes of the true investigator will usually include a liking for the elucidation of mysteries, and a liking for new and adventurous problems. These tastes are manifested by men whose walks of life and objects of interest are very different; but they are not common tastes, any more than the faculties needed in such inquiries are common. The scientific investigator wins pleasure or satisfaction where most men and women would find only vexation and futile effort. He finds fascinating what most men and women would find repellent.

After a new discovery has been made, another and quite different task awaits the successful investigator. He desires and needs to procure the acceptance of his discovery by the learned world, and in some cases by the commercial world. This is a process different from the process of discovery, and yet kindred. It involves demonstrations; but these demonstrations require a somewhat different sort of imagining and contriving from that which led to the discovery. The discovery was made in private; the demonstrations must be public. The discovery needed solitary reflection; to procure the acceptance of the discovery needs a power of public exposition, accompanied by debate and even controversy. The discovery required indomitable patience and energy in pursuing and verifying in rapid succession the conceptions or fancies of genius; the demonstration requires skill in discussion, courage in accepting public tests, and in taking responsibility for risking the property or lives of others.

The history of scientific research amply illustrates the stimulating value of controversy, and the contribution which free discussion makes to real progress. Freedom of thought and speech promotes progress towards truth in science just as effectively as it does the gradual attainment of truth and justice in government, industries and social structure. Time frequently shows that both sides were measurably right in honest scientific controversies, although one side win a temporary or even an ultimate victory.

The conditions under which research is necessarily performed deprive the investigators of the stimulus which numbers of students give to popular teachers. The laboratories of research contain but few students; and they are for the most part silent and absorbed. Nevertheless, the younger investigators have two great satisfactions in their work: they follow leaders

with hearty enthusiasm and loyalty, and the generous ones among them also maintain a stimulating comradeship with contemporaries in the same fields. Their number is very small in all the contemporaneous fields of inquiry put together; but it is on this small number that the real progress of any nation in the arts and sciences, and, therefore, in civilization and happiness, ultimately depends. Their Herculean labors are self-imposed, and they must set their own standards of excellence; for society can not supply men capable of supervising, regulating or stimulating them. The ordinary grades of public instruction can be supervised and disciplined; but the scientific investigator must be a law unto himself. The utmost that governments or universities can do for him is to provide suitable facilities and conditions for his work, and to watch for results.

Among the numerous varieties of scientific research such as chemical, physical, physiographical, astronomical and biological, medical research occupies a peculiar place. While it avails itself to the utmost of all the exact weighings and measurings of the other natural sciences, it is forced to deal with innumerable materials and conditions which are complicated and made obscure by vital forces. It has to deal with objects which are alive and with processes of organic growth or change. Its evidence can not always be exact; its experiments must often be complicated and obscured by vital reactions; and its results of highest value are often incapable of complete demonstration in the mathematical, physical or chemical sense; because dense shades of ignorance darken the environs of the practical result. Thus, preventive measures against a familiar and definite disease may succeed, while the promoting cause of the disease remains unknown, and the method of its transmission from one victim to another is but imperfectly understood. Vaccination succeeded when the cause or promoting condition of smallpox was unknown. The microbe of rabies is unknown, and yet protective inoculation against rabies has been invented and successfully applied. The mere mention of some of the contributory inventions and discoveries of the past fifty years, such as the principles of fermentation, artificial culture solutions, gelatine plate cultures, selective cultivation, the variety of sterilization conditions for different organic substances, staining technique, immunity through the use of a toxic organism that can be cultivated, increasing or diminishing at pleasure the virulence of a toxic organism, and testing toxins and vaccines on living animals, will readily satisfy even a sceptical mind that medical research has great difficulties of its own to encounter in addition to the usual difficulty of scientific inquiry in general. Biological research is, therefore, more arduous than physical, chemical or other inorganic research, because vital processes are difficult to observe accurately, and all the conditions of experimentation are harder to control. The medical investigator must often fish in troubled waters; and sometimes he can not find again the promising fishing ground he has once visited, because unexpected fog prevents him from seeing the intersecting bearings of his desired ground.

Again, medical research habitually strives to arrive at something beyond abstract truth. It seeks to promote public and private safety and happiness, and the material welfare of society. Its devotees have in mind the discovery of means of remedying misery or warding off calamity; and they also know that whatever contributes to health and longevity in any community or nation contributes to its industrial prosperity; so that they are justified in hoping for results from their work which will promote human welfare. In short, medical

research is research in science which is both pure and applied. Some genuine scientists affect to despise applied science; and certainly it is not discreditable to men of science that they are apt to value discoveries which have no popular quality or commercial utility more highly than those which immediately attract the favor of the multitude by their industrial effects, or by their striking novelty combined with intelligibility; but all scientists recognize the fact that medical research is directly related to the largest material interests of the community, such as manufacturing, transportation, sanitation and the methods of providing light, heat and shelter, and of defending the community against frauds in foods, drinks and drugs. Many of its problems are economic as well as medical, and require in those who study them sound judgment in money matters as well as knowledge of natural law and skill in scientific methods of inquiry. Medical research, therefore, requires in its devotees a combination of theoretical power with practical power—a capacity for both abstract science and applied science. This combination is rare but by no means unattainable. Indeed, abstruse speculation is almost always attractive to masters of the experimental method. The investigator absolutely needs a powerful imagination; but this imagination must be checked by the most rigorous experimentation.

In spite of the fact that medical research involves the suffering and death of many of the lower animals used for purposes of study, the work of medical research is in reality the most humane work now done in the world; for its secondary objects are to prevent disease in men and animals, to defeat the foes of life, to prevent the industrial losses due to sickness and untimely death among men and domestic animals, and to lessen the anxieties, terrors and actual calamities which impair or crush out human happiness. The primary object in medical research, as indeed in all research, is the ascertaining of truth; but these secondary objects are ever before the mind of the investigator, and through them come his greatest satisfactions. These satisfactions ought to be shared by men who, like the founder of this institute, promote medical research by the exercise of their sound judgment and good will and by their money.

The achievements of medical research since Jenner have been marvelous. Seeing what has been done within a century to diminish the mental and bodily sufferings of mankind from smallpox, diphtheria, rabies, tuberculosis, malaria, yellow fever, puerperal fever and typhoid fever, and to give surgery safe access to every part of the body, we may reasonably believe that equal triumphs, and even greater, await it in the future. May we not hope that America will contribute her full share to the progress of scientific research, finding no obstacle, but rather means of furtherance, in her democratic institutions? May not we democrats find encouragement in the humble origin of Franklin, Faraday and Pasteur, and in the contributions democratic America has already made to anesthesia, surgery, the improvement of public water supplies and the control of Texas fever, malaria, puerperal fever and yellow fever? May we not reasonably expect our country to produce many men like Louis Pasteur's father, a private soldier of the first empire and a hard-working tanner? In the dedication of his best book the great son said to his father: "The efforts I have devoted to these investigations and their predecessors are the fruit of thy example and thy counsel." Let American parents take that sentence to heart! And let all Americans reflect on another utterance of this greatest of contributors to medical science, this ar-

dent patriot, this independent and indomitable worker, this genuine democrat—Pasteur: "The true democracy is that which permits each individual to put forth his maximum of effort."

CHARLES W. ELIOT.

SCIENTIFIC BOOKS.

A College Algebra. By HENRY BURCHARD FINE. Ginn & Company. 1905.

The present day is remarkable for its production of large numbers of mathematical text-books. In most cases the aim of the writers of these books seems to be to convince the student that the subject treated is devoid of any element of interest, that it possesses no logical sequence, and that memory of a large assortment of unconnected facts is the only requisite for a sound mathematical training. One meets with proofs of theorems divided into first, second, etc., steps—an obvious attempt to burden the memory at the expense of the reasoning faculty, and stress is laid on the fact that all problems are 'easy,' in fact on examination they appear scarcely worth the name of problems. There is not the slightest doubt that these harmful books are one of the causes of the decrease in mathematical students at our colleges and universities. The books are, unfortunately, given a trial somewhere, no matter how bad they may be, and one can conceive of no surer way of destroying the interest of the young student in the subject. For those who are merely general students they are equally defective. In the forefront of an author's mind should be a desire to develop the reasoning faculties. Let us have easy exercises by all means, but let us also have exercises which will make students think for themselves. Let us develop our subject along the easiest sequence, but let us develop it logically.

Professor Fine's 'College Algebra' is in refreshing contrast to such books as I have mentioned. He aims at giving an exposition at once logical and easy to understand. The result is a book that must make the subject interesting to the ordinary college student. The work is divided into two parts. The first consists of 78 pages devoted to the ideas at the base of the notion of number, a development of those ideas which are associated with the names of Cantor, Dedekind and others. This difficult subject has been handled by the author with conspicuous clearness, and every student of it should make himself familiar with these first 78 pages. It is questionable, however, whether, even with Professor Fine's exposition, it is possible to make this subject really understood by a student who is just beginning his college algebra course, and possibly the author in later editions may decide to present this section as a separate book, under a separate title.

The second part, some 500 pages, is concerned with algebra proper. It is 'meant to contain everything relating to algebra that a student is likely to need during his school and college course.' Even this wide ideal is given a wide interpretation, and the last chapter, Properties of Continuous Functions, is a fitting introduction to the calculus. The chapters on the solution of equations are of special interest. The author makes much use of graphs, the only way to make clear to the student what is implied by the solution of a set of equations. It would have been of advantage to give a brief account of the generalization of the use of graphs to the case of three variables, and thus to prepare the mind for the idea of a space of more than three dimensions. Particularly noteworthy in connection with graphs is the discussion of inequalities. The idea of a graph as dividing the plane into two regions, in one of which $f(x, y) > 0$ in the other < 0, should certainly be emphasized in ordinary algebra, before the introduction of analytic geometry, as algebraic questions, otherwise unintelligible to the learner, become almost intuitive. Observe, for instance, the illuminating example on page 341.

The general theory of the solution of equations is developed in very effective form; in particular the treatment of symmetric equations. The important idea is the taking of the various simple symmetric functions as new auxiliary variables and, after solving for these, finding the solutions of a set such as,

for example, $x+y=a$, $xy=b$. Here it would be of use to point out that x and y are the roots of the quadratic $X^2-aX+b=0$, and similarly in the more general case. The chapter on convergence of infinite series leaves little to be desired. But the author might have given Cauchy's condensation theorem that under certain conditions

$$\sum_{n=1}^{\infty} f(n) \quad \text{and} \quad \sum_{n=1}^{\infty} a^n f(a^n)$$

converge or diverge together. This has been used to discuss the well-known case

$$\sum_{n=1}^{\infty} \frac{1}{n^k},$$

and is fundamental in the construction of the De Morgan criteria. The result of § 953 may well be obtained by comparison with the series

$$\sum \frac{1}{n^k}$$

and a more useful form is: The series converges or diverges according as

$$\lim_{n=\infty} n\left(\frac{u_n}{u_{n+1}}-1\right) \gtrless 0.$$

Dr. Fine has, unfortunately, been compelled to leave the exponential theorem to the last few pages of the book, and it would be an advantage if more space could be given to it in a later edition. Also the more logical development in the indicial, binomial and exponential theorems, and that of De Moivre would be to first prove that if $f(x)$ is any function of x which satisfies $f(x)\times f(y)=f(x+y)$, for all values of x and y, then $f(x)=[f(1)]^x$ for all values of x; and then to apply this in turn to each of the particular theorems.

The book as a whole is admirably complete, and for this reason many parts might with advantage be omitted on a first reading. These parts could be indicated in some manner, for example by means of asterisks.

J. EDMUND WRIGHT.

SOCIETIES AND ACADEMIES.

THE AMERICAN CHEMICAL SOCIETY. NEW YORK SECTION.

THE last regular meeting of the New York Section of the American Chemical Society was held at the Chemists' Club, 108 West Fifty-fifth Street, on Friday, June 8. The chairman, Dr. F. D. Dodge, presided. The following papers were read:

The Chemical Work of the Bureau of Standards: W. A. NOYES.

The chemical laboratories of the bureau of standards were ready for the beginning of work in March, 1905. There are at present five chemists working in these laboratories.

Dr. Stokes and Mr. Cain have been working upon the standards of purity for chemical reagents. Good progress has been made in securing cooperation of the chemical manufacturers in this work, and some progress has been made in the laboratory in the development of methods for testing for impurities in reagents, especially work of this character has been done with methods for determining traces of iron and work is being conducted upon the common acids and alkalies.

Dr. Waters has worked chiefly with Dr. Wolff upon the purification and testing of materials for the preparation of standard electrical cells. He also carried out last year the analysis of the argillaceous limestone which was distributed for the purpose of improving the analytical methods taught in our colleges and universities.

Dr. Weber has analyzed a sample of sulphide ore, a zinc ore, some agricultural samples for sulphur and some samples of white metal. These have been distributed chiefly among technical or agricultural chemists by different societies.

The bureau has taken over the standard samples of iron which heretofore have been distributed by the American Foundrymen's Association, and very careful analyses of these samples were made at the bureau by Mr. Cain.

Arrangements have been partially completed with the American Steel Manufacturers' Association for the preparation of a series of samples of standard steels of the three types, Bessemer, basic open hearth and acid open hearth.

Dr. Noyes has been working on the ratio between the atomic weights of oxygen and hydrogen, and recently he has taken up, in

conjunction with Dr. Weber, some work upon the atomic weight of chlorine.

Silver Platinum Alloys: J. F. Thompson and Edmund H. Miller.

The authors have investigated the cooling curves and micro structure and determined the electrical conductivity and specific gravity of alloys containing up to 57 per cent. of platinum.

Several series of experiments on the effect of parting with nitric or sulphuric acid on platinum silver alloys have been run, showing (1) that the separation of platinum from iridium, gold, etc., in one operation by means of alloying with silver and parting in nitric acid is impossible, and (2) that analytical results on platinum silver alloys based on parting with concentrated sulphuric acid are incorrect on alloys containing 20 per cent. or more of platinum, unless corrected for silver retained by the platinum residue.

Chemical and Physiological Examination of the Fruit of Chailletia Toxicaria: F. B. Power and F. Tutin.

The *Chailletia Toxicaria* grows abundantly in West Africa and South America, and belongs to the natural order of Chailletiaceæ. It is known in Sierra Leone as ratsbane. It contains a poisonous substance which is frequently used by the natives of the districts where it grows for poisoning one another.

Domestic animals poisoned by it become paralyzed in the hind limbs; subsequently the fore limbs and chest muscles are also paralyzed, and death results from paralysis of the respiratory center.

The results of the examination of well-authenticated material were as follows:

No alkaloid, cyano-genetic glucoside, or soluble proteid, with poisonous properties, could be isolated.

About two per cent. of fat is present in the fruit, in which were found (1) oleo-di-stearin, of m.p. 43°; (2) phyto-sterol, $C_{28}H_{44}O$, m.p. 135°–148° (3) stearic and oleic acids; (4) small amounts of formic and butyric acids.

The alcoholic extract, free from fat, yielded a resinous mixture (2.5 per cent. of fruit), from which nothing crystalline could be obtained.

By successive extraction with chloroform, ethyl acetate and alcohol it was, however, resolved into products differing in their physiological action.

The chloroform extract had a narcotic or paralytic effect: the ethyl acetate extract produced delirium and convulsions, the alcoholic extract was not distinctly toxic.

The aqueous extract, free from resin and tannin, contained much glucose and was extremely poisonous.

All attempts to separate the sugar from the poison were without result.

The physiological experiments led to the following deductions: (1) The fruit contains at least two active principles, one of which causes cerebral narcosis, and the other cerebral excitation, leading to epileptiform convulsions. (2) The poison which causes convulsions is very slowly excreted, so that a cumulative effect is produced by the administration of a series of individually innocuous doses.

Quinazolines from 4-Amino-1, 3-Xylene: J. E. Sinclair and M. T. Bogert.

The xylidine was converted into its acetyl derivative, and this then oxidized to the acetamino isophthalic acid. The latter yielded an anthranil when boiled with excess of acetic anhydride, and by condensing this anthranil with various primary amines, quinazolines were obtained carrying a carboxyl group on the benzene nucleus. The amines used were ammonia, methylamine, ethylamine and aniline.

Quinazolines from 3-Amino-1, 4-Xylene: J. D. Wiggin and M. T. Bogert.

By a process similar to that outlined above, this xylidine was oxidized to the acetamino terephthalic acid, which was then changed to the anthranil, and the latter condensed with primary amines to quinazolines. The quinazolines thus produced differ from those mentioned above in the location of the carboxyl group on the benzene nucleus. The amines used were ammonia, methylamine, ethylamine and aniline. Other quinazolines were ob-

tained by heating the amino terephthalic acid with formamide, urea, etc.

Condensation with p-Diamino Terephthalic Ester: J. M. NELSON and M. T. BOGERT.

p-Diamino terephthalic ester was condensed with phenyl isocyanate, phenyl isothiocyanate, and with formamide, giving various complex heterocycles. From these substances various derivatives were prepared and studied, many of which were found to be strongly fluorescent.

Officers of the section for the year 1906–07 were elected as follows:

Chairman—A. A. Breneman.
Vice-chairman—H. C. Sherman.
Secretary-Treasurer—C. M. Joyce.
Executive Committee—G. C. Stone, C. H. Kiessig, V. Coblentz, D. Woodman.

F. H. POUGH,
Secretary.

THE TORREY BOTANICAL CLUB.

ON May 23, 1906, the club held a special meeting in commemoration of the tenth anniversary of the commencement of work in the development of the New York Botanical Garden.

The meeting was held in the lecture hall of the museum building at the garden, with President Rusby presiding.

After the election of new members the club listened to an illustrated lecture by its president on 'The History of Botany in New York City.'

Dr. Rusby presented a historical sketch of the development of botany in the city of New York, giving special attention to the history of local botanical gardens, of the botanical department of Columbia College and of the Torrey Botanical Club. The earliest local work related to the botanical gardens of Colden, Michaux and Hosack, and to the publication of local catalogues and floras. The second period was that of text books, manuals and other educational works. Out of the associations resulting from local work, the Torrey Botanical Club developed so gradually that it is impossible to fix the date of its actual beginning. Portraits of its early members were exhibited and brief biographical sketches presented. Out of the activity of the club and of the botanical department of Columbia grew the demand for a great botanical garden, which was satisfied by the establishment of the present New York Botanical Garden. The contemporary botanical forces at work in the city were briefly described, and their most important present needs outlined. The complete address will be published in *Torreya* for June and July, 1906.

The lecture was followed by an informal reception in the library, and by an inspection of the library, laboratories, herbaria and the museum exhibits. C. STUART GAGER,
Secretary.

DISCUSSION AND CORRESPONDENCE.

INTERCOLLEGIATE ATHLETICS AND SCHOLARSHIP.

To begin with, and to end with, I have no opinions to offer, no theory to defend, no purpose to dispose of a broad and complicated problem with a few general sweeps of rhetoric. Without such credentials, I dare not appear in public under so weary and worn a topic. Intercollegiate athletics has had so much talking about it and one must be bold indeed—usually too bold—who ventures more mere opinion. On whatever phase of education the organization of contemporary experience can yield facts, it is an old and pernicious habit to guide practise by mere opinion. On such subjects one man's opinion is about as good as that of another, and neither is worth much. The quantity of opinion on the subject of football is to the quantity of fact in about the same relation as the forty thousand yelling spectators to the little pile of men on the gridiron. My present purpose is to contribute a body of facts to one single phase of the problem.

Athletics are denounced in arguments as numerous and as varied as those recklessly put forth on the other side. On both sides of the question we hear some reason and much exaggeration, some fact and much opinion. Those who oppose football as played last fall in American schools and colleges hold that the game is injurious to healthful student life on account of the large number of injuries re-

ceived in play and practise, on account of extreme publicity, absurd exaltation of the hero, large amounts of money spent, immoral tendencies inherent in the game itself, professionalism, and finally because of the harmful influences on scholarship. On the last of these alleged evils at least, facts are available.

To aver that trustworthy conclusions on the relation of scholarship and athletics can be drawn only from hundreds of cases covering a number of years would seem a trite observation, if one were not daily confronted with opinions based on absurdly insufficient data, and stoutly maintained. Mrs. A. is perfectly sure that all athletics should be abolished, because, forsooth, her boy played on a football team and failed to pass his examinations. Mr. B. regards such an opinion as absurd, because he knows of a whole team which failed not of promotion. Both are equally firm in their opinions and equally regardless of the fact that the whole question is a relative one, and that general truths can not be established by exceptional data.

It seems, on the other hand, that conclusions concerning the effect of athletics on scholarship might be creditable if based on years of experience, scores of studies, hundreds of students and thousands of grades, recorded by a large number of teachers in several institutions. Such conclusions I have gathered with great care, and I now offer them for what they are worth.

At Bates College, Lewiston, Me., I examined the records in all studies for the past five years of the 132 men who have played on the baseball and football teams. These records I compared with those of all the other male students, 620 in number, in all studies for the same period. The averages thus reached are drawn from 2,030 grades for athletes and 9,320 grades for others. These grades were made up by twenty-five instructors. The table shows that in no year is the difference of rank more than eight per cent. or less than four per cent., and that the average difference is 5.6 per cent., always in favor of the men who have not taken part in intercollegiate games.

BATES COLLEGE.

	Athletes.	Non-athletes.
1900–1901	77	81
1901–1902	75	80
1902–1903	74	80
1903–1904	73	79
1904–1905	71	79
Average	74	79.6
No. of grades.....	2,030	9,320
No. of men.....	132	620

For Bowdoin College a similar table has just been compiled by students in education at that college, showing the ranks attained by all students in all courses for the past five years. The averages only are here given. The first table represents the ranks of all men who played regularly on the football and baseball teams; the second table includes the ranks of all other students. The averages are secured from 18,750 individual ranks, representing each year the scholarship records of 280 men. The tables show that each year the rank of the baseball and football players was lower than that of the other students, the difference varying from one per cent. to five per cent. For the whole five years the average rank of all athletes in all studies was 77.57; that of all other students was 80.37.

BOWDOIN COLLEGE.

	1899-1900	'00-'01	'01-'02	'02-'03	'03-'04	Aver.
Athletes.						
Seniors	85.2	76.43	79.2	78.14	80.	79.79
Juniors	75.	82.75	75.4	76.	79.	77.63
Sophomores	78.67	79.14	77.	71.57	78.5	76.97
Freshmen	75.3	84.	77.5	69.	71.5	75.6
Whole college	81.1	79.16	76.68	73.67	77.2	77.57
Non-athletes.						
Seniors	82.6	81.51	82.09	82.09	84.5	82.5
Juniors	86.	80.07	79.	79.8	83.	81.51
Sophomores	82.	79.47	78.20	78.74	79.	79.5
Freshmen	79.7	81.	75.97	74.98	80.5	82.4
Whole college	82.05	80.51	78.59	78.88	81.7	80.37

All the varied secondary schools for which I have adequate returns show similar records. At Bridgton Academy, a rural school of the old type, the ranks for four years show that the athletes are one per cent. below the other students. At Thomaston, a typical high school for small cities, the athletes for four years fell three per cent. below the others.

At Westbrook Seminary, a private city school, the athletes are slightly below the others. At Hebron Academy, the largest in Maine, the athletes, for a period of three years, fell five per cent. below the non-athletes. In all the secondary schools for which I have trustworthy records, the athletes fall lower, but never more than five per cent. lower, than other students.

These facts regarding the relative scholarship of athletes and non-athletes cover the records of about two thousand students in six institutions for five years. The facts were gathered by twenty men of varied opinions on the question, who were not endeavoring to make the figures prove any theory or support any opinion. So far as the facts go, they are authentic. They overthrow two thirds of the *a priori* assumptions regarding the *excessive* injury of intercollegiate games to the scholarship of the men who play.

WILLIAM TRUFANT FOSTER.
BOWDOIN COLLEGE,
BRUNSWICK, MAINE.

NOTE ON THE YPSILOID APPARATUS OF CRYPTOBRANCHUS.

A DESCRIPTION of this cartilage in a recent article by Whipple ('The Ypsiloid Apparatus of Urodeles,' *Biol. Bull.*, May, 1906) differs radically from the description by Reese ('The Anatomy of *Cryptobranchus*,' *American Naturalist*, April, 1906). According to Whipple the cartilage has the typical Y-shape common to urodeles, being bifurcated at the anterior end; according to Reese it is rod-shaped. Having an abundance of material at my disposal, I examined this apparatus in a number of specimens. In every case the cartilage is Y-shaped, but with a marked difference in the structure of the anterior and posterior regions: the posterior portion, forming the stem of the Y, consists of a stout rod of cartilage; the expanded V-shaped anterior portion is very thin. In a dry preparation this thin expanded anterior portion would probably shrivel up and might be easily detached and hence overlooked; the remaining portion would then answer the description given by Reese. It is evident that in its entirety this apparatus has the typical urodele form.

B. G. SMITH.
ZOOLOGICAL LABORATORY,
UNIVERSITY OF MICHIGAN,
ANN ARBOR, MICH.

A NEWLY-FOUND STONY METEORITE.

THE writer has received notice from a correspondent in Alabama of the finding, near Selma, in that state, of a heretofore undescribed meteorite. The mass is reported as weighing upwards of 300 pounds, and is of Brezina's kugel chondrite type, much resembling the well-known stone from Tieschitz, in Moravia. It will be known as the Selma, Alabama, stone. A detailed description will be published later.

GEO. P. MERRILL.

SPECIAL ARTICLES.

THE GREAT CATALOGUE AND SCIENTIFIC INVESTIGATION OF THE HEBER R. BISHOP COLLECTION OF JADE.[1]

THREE years ago, on January 3, 1903, it was my sad duty to read before this section of the American Association for the Advancement of Science, at its meeting in Washington, a notice of the death of Mr. Heber R. Bishop, accompanied by a brief description of his remarkable collection of jade objects (see *Amer. Anthropologist*, N. S., Vol. 5, January-March, 1903, pp. 111–117). See also the Metropolitan Museum Bulletin for May, 1906.[2]

Since that time this magnificent collection, which was presented by Mr. Bishop during his lifetime to the Metropolitan Museum of Art, in New York, has been arranged and installed. He made a large donation for this purpose, and had had prepared and fitted up for its suitable exhibition the northeast room on the second floor of the new wing of the museum

[1] Read before the American Association for the Advancement of Science, New Orleans meeting, December 31, 1905.

[2] See the printed catalogue of the Heber R. Bishop Collection of Jade. By George F. Kunz. Occasional Notes No. 2, Bull. Metropolitan Museum of Art, May, 1906, pp. 1–8. 8vo. Three illustrations.

building, to be known as Bishop Hall. This room he had arranged and decorated by the noted firm of Allard Frères, of Paris, to make it the finest example on this continent of the style of Louis XV. The collection is here placed in some fifteen elegant cases, of gilt bronze and plate glass, all in Louis XV. style, which with the decorations of the room, illustrate a permanence and richness of material never excelled in the time of the artistic French monarch himself.

In my notice before mentioned, reference was made to the remarkable volume describing this collection, and to the studies and researches in connection with it provided for and sustained by Mr. Bishop. It is a pleasure to me to be able to state that at the present time the entire edition of this unique work, limited to one hundred copies, is not only printed but bound. The two copies required by law, in order to secure the copyright, are already placed in the National Library; and by January 2 the whole edition of this sumptuous publication, so valuable from both a scientific and an artistic standpoint, will be distributed, or at least on its way, to the crowned heads and the important public institutions that are to receive copies by the terms of Mr. Bishop's will. In no case will the book go to any private individual, and in no case will it be sold.

The two volumes (stately folios)[1] are printed on the finest quality of linen paper, and weigh respectively 69 and 55 pounds, or 124 pounds together. They contain 570 pages (Vol. I., 277 pp.; Vol. II., 293 pp.), measuring 19-15/16 by 26-1/4 inches. There are 150 full-page illustrations, in the highest style of execution—water-color, etching and lithograph, and nearly 300 pen-and-ink sketches in the text. In cost, this great work is double that of the monumental folio of Audubon's 'Birds of America,' amounting to about $2,000 a copy, and stands alone as perhaps the greatest volume ever issued, and certainly the greatest catalogue of a collection in any branch of science or art. The total expense of 100 copies being $185,000.

The preparation of this great work was made possible by the princely liberality of Mr. Bishop, who had planned it fully since about 1886. To carry out these plans to their completion in the final distribution now to be made, has taken, therefore, just about twenty years. No expense nor care was spared in the execution; some thirty scientific men and art specialists, both in Europe and America, were engaged to contribute their views upon various aspects of the whole subject; and the illustrations were prepared in the finest possible manner, Chinese and Japanese artists being employed to execute many of them, and color experts being freely consulted, with the supervision of Mr. Bishop himself.

The catalogue has, moreover, a special value from the fact that all the scientific investigations described therein were made upon material taken from specimens in the collection itself. These studies were in charge of the writer, assisted by a number of scientific specialists of the highest standing, and deal with all the physical properties of the different varieties of jade.

A full list of collaborators is as follows:

Dr. George Frederick Kunz, in charge of the mineralogical and archeological articles and descriptions.

Dr. Stephen W. Bushell, G.M.G. (Chinese article).

Dr. Robert Lilley (editor).

Tadamasa Hayashi (Chinese and Japanese).

Dr. William Hallock, professor of physics in Columbia University, New York.

Dr. S. L. Penfield, M.A., professor of mineralogy, Yale University.

Dr. Henry W. Foote, Sheffield Scientific School at Yale University.

Dr. Joseph P. Iddings, professor of petrology at University of Chicago.

Professor F. W. Clarke, chief chemist, U. S. Geological Survey.

Mr. Ira Harvey Woolson, adjunct professor of engineering at Columbia University.

Mr. Logan Waller Page, expert in charge of physical tests, Division of Chemistry, Department of Agriculture, Washington, D. C.

[1] 'Catalog and Investigations in Jade,' published by Heber R. Bishop (folio), New York, 1906.

Dr. Charles Palache, professor of petrography, Harvard University.

Mr. Louis V. Pirsson, professor of petrography, Yale University.

Dr. Henry S. Washington, petrographer.

Professor L. von Jaczewski, professor of mineralogy and geology at the University of Ekaterinoslav, St. Petersburg.

Herrn Geheimrath Dr. A. B. Meyer, director Königliches Zoologisches und Anthropologisch-Ethnographisches Museum, Dresden.

Herrn Dr. Max Bauer, director Mineralogisches Institut der Königliches Universität, Marburg (Hessen).

Mr. Robinson, artist.

Dr. Thomas Wilson, late curator, Division of Prehistoric Archeology, Smithsonian Institution, U. S. National Museum, Washington.

Dr. Joseph Edkins, of Shanghai.

Professor A. Damour, of Paris.

Dr. Ludwig Leiner, curator of Rosegarten Museum, Constance.

Mrs. Zella Nuttall, Peabody Museum, Cambridge, Mass.

Miss Eliza Scidmore.

Dr. F. Berwerth, Mineralogisches Abtheilung, Hof Museum, Vienna.

Professor Ernst Weinschenk, professor of petrography at the Mineralogisches Institut, Munich.

The Field Columbian Museum, Chicago.

The Smithsonian Institution, Washington, D. C.

The Museum of Natural History, New York.

The following French etchers were represented: Sulpis, Guerard, Richard, Piquet, Le Rat, Coutry and a number of plates by Smillie of the United States.

The lithographs are by Prang & Co., and Forbes & Co., of Boston.

Name of maker of paper, the finest hand-made linen paper, especially made by the L. L. Brown Paper Co., Adams, Mass.

Name of printer, Theo. L. De Vinne & Co., Lafayette Place, New York. It is the most important work that has ever come from the De Vinne press.

Name of binders, Stikeman & Co., New York. Bound in full Levant with exquisite tooling. No hundred volumes have ever received such stately bindings of green Levant as was produced by Stikeman & Co.

The tools for the decorations by George W. De Lacey.

A series (twelve full-page) of water-color sketches of all the processes of working jade in every possible manner was made in China by Chinese artists.

The original lithographic color plates were laid out on the lines of 'Gems and Precious Stones of North America.'

Among great illustrated books there are, Audubon's folio of birds, Svenegrodzkoi, 'Byzantine Animals,' published in Russia, Gould's 'Birds of Many Lands,' the great illustrated catalogue of Chinese porcelain of the Walters collection, issued by Mr. Henry Walters, the treasures of Tzarkoe Zelo, by the Russian governor, catalogue of the J. P. Morgan collection of Oriental porcelains. Magnificent as these all are, each in its own way, none of them possesses the great variety of artistic illustrations as does the great Heber R. Bishop catalogue.

This whole work, from its inception by Mr. Bishop in 1886 to the final distribution of the volumes, has required about twenty years. It is a cause for much satisfaction that the enterprise has been so fully and successfully completed, along the lines which he laid down; but it is also a source of profound regret that he could not himself have lived to witness its final place.

This whole cost has been met by the liberality of Mr. Bishop's provision, carried out by the care and thoughtfulness of his three executors, Messrs. Moses Taylor, Frank C. Bishop and Alexander James Patterson.

I must here express my thanks and appreciation to Mr. Alexander James Patterson, who has been untiring in his zeal and carefulness throughout the entire carrying out of Mr. Bishop's wishes, both written and unwritten, and to whose courtesy I am indebted for many of these facts, furnished me for the preparation of this article.

GEORGE FREDERICK KUNZ.

THE ROCK OF THE PELÉE OBELISK AND THE CONDITION OF THE VOLCANO IN FEBRUARY, 1906.

THE measure of doubt which has all along attached to the character and constitution of

the rock-mass which built up the great Pelean monolith may probably now be considered removed. A period of many months' quietude into which the volcano has entered has also permitted of a closer approach to its center theater of activity than has hitherto been possible, and given access to parts the study of which can now be made directly rather than inferentially. The Pelée obelisk exists to-day only in its basal wreck, the jagged crest which still protrudes in a partially severed connection from the summit of the supporting dome, and in a wilderness of débris, composed of small and giant fragments, which covers much of the surface of the dome and fills in a considerable part of the circumvallating hollow (*rainure*) that separates the dome from the bounding wall of the ancient crater-basin. On the twenty-seventh of February of this year, following an unusually easy ascent of the volcano, I succeeded in gaining the floor of the old crater by climbing over the sharp arête of the northeast wall, and was soon among the boulder-masses of the destroyed obelisk. Fragments from two to three feet in diameter to others measuring ten, twenty or thirty feet, were everywhere, and they all showed practically the same construction. The rock is a compact, light-gray, and virtually holocrystalline hypersthene-andesite, devoid of vesicles or of any vesicular or obsidian-like structure, and having a fine-grained base. So far as an absolute reference is made possible, it seems to belong to Lacroix's type IV. (quartzitic andesites) of the ejected material from the volcano.[1] Of course, it can be that in parts of the débris that are now covered up and no longer accessible fragments might occur that are more or less vesicular or scoriaceous in character, but in the very large number of blocks that were examined by me and my associate none having this character was detected.

Climbing over the boulders, somewhat in the form of stepping-stones, we gained a considerable height on the dome itself, passing a number of fumarolic vents from which the disengagement of vapor was still fairly active. Clumps of diminutive fern are now beginning to grow about these. The partially free flows of lava which enter as ribbed-structures into the mass of the dome appear likewise as compact andesite. I may remark here that the sound of the falling masses which has been likened to that produced by the breaking of glass and porcelain, and from which a possible vesicular structure was inferred, is that given out by the compact andesite.

As regards the origin and method of formation of the extruded andesite monolith, while recognizing that the criteria for distinguishing between a newly-made rock and one of ancient date are not necessarily apparent or of a nature to yield positive evidence, I have no reason to change the view that I have elsewhere expressed[2] that it represented an ancient plug or core that had been lifted up in the manner of the giant granite mass (and domite?) of the Puy Chopine, of the Auvergne.

For the benefit of vulcanologists and seismologists who are preparing catalogues of eruptions and general volcanic disturbances it may be proper to add that, despite reports to the contrary, Pelée had *not* been in activity in the early part of this year, and it took no part, so far as outward appearances were concerned, in the events which were associated with the earthquakes in St. Lucia and Martinique on February 16. The dome in its upper parts is still quietly disengaging vapor.

Angelo Heilprin.

[1] Professor L. V. Pirsson, of the Sheffield Scientific School, has kindly looked over some of the material for me. A more detailed study of the rock will be made at a future day.

[2] In Science and in my 'Tower of Pelée.'

THE COMMISSION FOR BRAIN INVESTIGATION.

On May 27 the third meeting of the Commission for Brain Investigation was held at Vienna. This commission is one of several established by the International Association of Academies and has for its purpose the advancement of neurological research, especially by the establishment of central institutes in the various countries, as well as by

the coordination of investigations in the field of neurology.

The first session was held in the Imperial Academy of Sciences. Professor Waldeyer presided and there were present:

Donaldson (Philadelphia), Ehlers (Göttingen), Flechsig (Leipsic), Langley (Cambridge), v. Monakow (Zürich), Munk (Berlin), Obersteiner (Vienna), Retzius (Stockholm).

The members of the commission unable to attend were:

Bechteren (St. Petersburg), Edinger (Frankfurt-am-Main), van Gehuchten (Louvain), Golgi (Pavia), Mall (Baltimore), Minot (Boston), Ramon y Cajal (Madrid), Raymond (Paris), Sherrington (Liverpool).

The first session was devoted to the further organization of the commission and to the presentation of reports on the scientific and financial resources of the several institutes and laboratories there represented. Steps were taken also to facilitate intercommunication between the various institutes.

May 28 the second session was held in the Neurological Laboratory directed by Professor Obersteiner. The commission was enlarged by making the number of members from each country more nearly representative of the extent of the neurological work.

At the suggestion of Professor Langley a committee on the revision of some points in the neurological nomenclature was formed, with Professor Waldeyer as chairman.

It was decided to make English, French, German or Italian the official language of the commission—according to the place of meeting.

The commission then adjourned to meet three years hence at the call of the academy in charge.

WILLIAM T. SEDGWICK.

FESTSCHRIFT CELEBRATION.

THURSDAY, June 14, at the Hotel Westminster, Boston, a dinner was given to Professor W. T. Sedgwick, by his former students in the biological department of the Massachusetts Institute of Technology, of which he has been the head since 1883. The occasion was the twenty-fifth anniversary of the receipt of his doctor's degree from Johns Hopkins University.

Sixty former students of Professor Sedgwick's at the institute were present, including, among others, Professor E. O. Jordan and Professor A. P. Mathews, of the University of Chicago; Professor Severance Burrage, of Purdue University; Professor G. N. Calkins, of Columbia University, and Messrs. G. W. Fuller, G. C. Whipple and Allen Hazen, of New York; M. O. Leighton, of the United States Geological Survey; Dr. E. C. Levy, city bacteriologist of Richmond, Va.; F. F. Longley, superintendent of the Washington filter plant; W. S. Johnson, of the Massachusetts State Board of Health; B. R. Rickards, city bacteriologist of Boston; Dr. Augustus Wadsworth, of the College of Physicians and Surgeons, New York; Dr. F. S. Hollis, of the Yale Medical School; E. E. Lochridge, engineer of the Springfield water department; Dr. F. W. White, of Boston; Dr. J. A. Rockwell, Jr., of Cambridge; Edward G. Gardiner and Robert S. Weston, of Boston; Dr. Robert P. Bigelow; Professor Theodore Hough, of Simmons College; Professor B. E. Stone, of Amherst; S. D. Gage, of the Lawrence Experiment Station, and Professor S. C. Prescott, Professor C.-E. A. Winslow and Earle B. Phelps of the institute.

There were also present as guests, former President D. C. Gilman, of Johns Hopkins University; Professor S. F. Clarke, of Williams College; President Henry Lefavour, of Simmons College; Dr. L. P. Kinnicutt, of the Worcester Polytechnic Institute, and Dr. Francis H. Williams, of the corporation of the Massachusetts Institute of Technology.

Dr. Calkins acted as toastmaster. President Gilman, who conferred Professor Sedgwick's doctor's degree in 1881, and Professor Clarke, who was a student with him, spoke of the early days of Johns Hopkins University, to which the biological department of the Institute, through Professor Sedgwick, owes its inspiration. Mr. G. W. Fuller, Professor E. O. Jordan, Professor A. P. Mathews, Mrs.

Stanley McCormick and Professor C.-E. A. Winslow made brief addresses expressing the regard and affection of the former students of the department for its head.

The evening closed with a speech by Professor Sedgwick himself in which he expressed his appreciation of the occasion, and spoke of his connection with the great university at Baltimore and the great technical school in Boston, and of the duty which now rests upon the biological department of the institute, to train men for the conduct of the sanitary reforms which are spreading so rapidly all over the union.

The chief event of the occasion was the presentation of a volume of biological studies, 'dedicated by his pupils to William Thompson Sedgwick, to express their regard and admiration for him as a friend, teacher, investigator and public-spirited citizen, and also to affirm their loyalty to the ideals for which he has always stood.' The volume, which has been prepared in secret and was a complete surprise to its recipient, has been published at the University of Chicago press under the editorship of Professor E. O. Jordan. It contains nineteen original contributions to biology and sanitary science, the authors and titles being as follows:

Gary N. Calkins: 'Paramecium aurelia and Paramecium caudatum.'

Harrison G. Dyar: 'The Life-History of a Cochlidian Moth, *Adoneta bicaudata* Dyar.'

George W. Fuller: 'Experimental Methods as Applied to Water- and Sewage-Works for large Communities.'

Marshall O. Leighton: 'The Futility of a Sanitary Water Analysis as a Test of Potability.'

George C. Whipple: 'The Value of a Pure Water.'

A. P. Mathews: 'A Contribution to the General Principles of the Pharmacodynamics of Salts and Drugs.'

Percy G. Stiles and Carl S. Milliken: 'An Instance of the Apparent Antitoxic Action of Salts.'

Edwin O. Jordan: 'Experiments with Bacterial Enzymes.'

C.-E. A. Winslow and Anne F. Rogers: 'A Statistical Study of Generic Characters in the Coccaceæ.'

Samuel C. Prescott: 'The Occurrence of Organisms of Sanitary Significance on Grains.'

Stephen DeM. Gage: 'A Study of the Numbers of Bacteria Developing at Different Temperatures and of the Ratios between Such Numbers with Reference to Their Significance in the Interpretation of Water Analysis.'

C.-E. A. Winslow and E. E. Lochridge: 'The Toxic Effect of Certain Acids upon Typhoid and Colon Bacilli in Relation to the Degree of Their Dissociation.'

Earle B. Phelps: 'The Inhibiting Effect of Certain Organic Substances upon the Germicidal Action of Copper Sulphate.'

Daniel D. Jackson: 'A New Solution for the Presumptive Test for Bacillus Coli.'

Henry S. Ayers: 'B. Coli in Market Oysters.'

Augustus Wadsworth: 'Studies on Simple and Differential Methods of Staining Encapsulated Pneumococci in Smear and Section.'

Arthur I. Kendall: 'An Apparatus for Testing the Value of Fumigating Agents.'

Theodore Hough and Clara E. Ham: 'The Effect of Subcutaneous Injections of Water, Ringers Fluid, and Ten Per Cent. Solution of Ethyl Alcohol upon the Course of Fatigue in the Excised Muscles of the Frog.'

Burt R. Rickards: 'Notes on a Case of Apparent Pulmonary Tuberculosis Associated with the Constant Presence of Diphtheria-Like Organisms in the Sputum.'

SCIENTIFIC NOTES AND NEWS.

Yale University has conferred the degree of doctor of science on Professor Henry H. Donaldson, head of the department of neurology of the Wistar Institute of Anatomy, of the University of Pennsylvania, and on Dr. Francis Bacon, professor of surgery in the Yale Medical School; and the degree of doctor of laws on Dr. William W. Keen, professor of surgery at Jefferson Medical College, Philadelphia.

Amherst College conferred its doctorate of science on Dr. James Furman Kemp, professor of geology at Columbia University, and its doctorate of laws on Dr. Walter F. Willcox, professor of political economy and statistics at Cornell University.

Wesleyan University has conferred the degree of doctor of science on Dr. Ch. Wardell Stiles, of the Public Health and Marine Hos-

pital Service; on Edward Dennett Rowe, of the National Bureau of Standards, and on Dr. A. C. True, of the Office of Experiment Stations, U. S. Department of Agriculture.

HARVARD UNIVERSITY has conferred its doctorate of laws on Professor G. H. Palmer, professor of ethics at the university.

AT the recent commencement of the University of Michigan the honorary degree of doctor of science was conferred upon Professor William A. Locy, of Northwestern University.

PROFESSOR ERNEST RUTHERFORD has received the degree of doctor of laws from the University of Wisconsin.

DARTMOUTH COLLEGE has conferred the degree of doctor of science on Dr. Warren Upham, librarian of the Minnesota Historical Society.

MR. F. C. S. SCHILLER, tutor at Corpus Christi College, has received the degree of D.Sc. from Oxford University.

THE University of Dublin will confer the honorary degree of Sc.D. on Colonel David Bruce, C.B., professor of tropical medicine at the Army Medical College; Professor J. H. Poincaré, professor of mathematics and astronomy at the Sorbonne; Mr. E. T. Whittaker, F.R.S., fellow of Trinity College, Cambridge, astronomer royal of Ireland; and Dr. A. E. Wright, F.R.S., pathologist and bacteriologist at St. Mary's Hospital, London.

THE University of Manchester will confer the degree of D.Sc. on Dr. Emil Fischer, professor of organic chemistry in the University of Berlin, and on Dr. Adolf von Baeyer, professor of organic chemistry in the University of Munich.

PROFESSOR SIMON NEWCOMB has been elected a member of the board of overseers of Harvard College.

DR. WM. MCMURTRIE, vice-president of the American Association for the Advancement of Science in 1895 and president of the American Chemical Society in 1900, has been elected a trustee of Lafayette College.

DURING commencement week at Harvard University, the research students of Professor E. H. Hall presented him with a silver loving cup. The occasion was the completion of twenty-five years of service in the department of physics of the university. The cup bore the following inscription:

"To
Edwin Herbert Hall
From his research students
In testimony
of their esteem and gratitude;
In appreciation
of his work in the field of discovery;
his quarter-century of service
in behalf of Harvard University.

His life an inspiration."

DR. GEORGE MACKLOSKIE, from 1875 professor of biology at Princeton University, has been appointed professor emeritus.

THE prize of the Peter Wilhelm Müller foundation at Frankfort, consisting of a gold medal and 9,000 Marks, and awarded for the most important contributions to science, has been given to Dr. Ludwig Boltzmann, professor of theoretical physics at Vienna.

DR. STUTZER, assistant in the geological institute of the Freiburg (Saxony) Mining School, has been awarded a grant of 2,000 Marks by the committee of the Carnegie fund, to enable him to continue his investigations on iron deposits in Lapland.

PROFESSOR F. B. CROCKER, of Columbia University, has sailed for England. He will attend the meeting of the Institution of Electrical Engineers of Great Britain.

DR. ALEXANDER HILL, master of Downing College, Cambridge, has gone to West Australia to give university extension courses and to awaken interest in the establishment of a university in the colony.

PROFESSOR A. BERGT has been made acting director of the Leipzig Museum of Ethnology, in the room of the late Professor Obst.

DR. FRANCESCO PORRO, professor at the University of Genoa, has been appointed director of the National Observatory at La Plata.

AT the Institute for the Experimental Investigation of Cancer at Heidelberg, Freiherr von Dungern, M.D., has been appointed head of the scientific department, and Privatdocent

von Wasielewski, head of the department of parasitological research.

Professor Edward C. Pickering, director of the Harvard College Observatory, was selected to deliver the Phi Beta Kappa oration at Harvard University on June 28.

According to the London *Times* an opinion has been widely expressed, both in Oxford and elsewhere, that the services rendered to archeology by Dr. Arthur John Evans should be commemorated by a portrait to be deposited in the Ashmolean Museum, of which he has for nearly a quarter of a century been keeper. The discoveries at Knossos are alone more than sufficient to justify this step; but Dr. Evans's achievements as a numismatist, historian and traveler have also earned for him the admiration of scholars. It is felt, moreover, that no more appropriate place for a memorial of him could be selected than the institution which has been raised, in the period during which he has presided over it, and mainly as the result of his energy, generosity and tact, to a place in the front rank amongst European museums. A committee, of which Dr. G. A. Macmillan (St. Martin's Street, London, W. C.) is the honorary treasurer, has been formed to promote the object in view. The portrait will be painted by Sir W. B. Richmond, and a reproduction in photogravure will be sent to every subscriber.

We regret to record the death of Lieutenant Forbes Tulloch, R.A.M.C., which occurred in the Queen Alexandra Military Hospital, Millbank, on June 20. Lieutenant Tulloch contracted sleeping sickness in Uganda, where he had been sent under the auspices of the Colonial Office as a member of a commission appointed to investigate the causes of the disease and the means of prevention.

The death, at the age of seventy-nine years, is announced of Sir George Thomas Brown, C.B., who was for many years chief of the Veterinary Department of the Privy Council and afterwards of the Board of Agriculture.

Nature reports the death of M. Edouard Piette, the distinguished archeologist, in his eightieth year. M. Piette was well known for his discoveries of prehistoric remains, among which may be mentioned those in the caverns of Mas d'Azil (Ariège) and of Brassempouy (Landes). Before his death M. Piette presented his invaluable collections to the Museum of Saint-Germain-en-Laye.

The senate committee on foreign relations has authorized Senator Bacon to report favorably the protocol providing for the establishment of an international institute of agriculture at Rome, Italy. There are about forty governments party to the arrangement. Studies will be made of all kinds of plant life and means of extermination of insects and other pests. The institute will receive the reports of the agricultural bureaus and societies of all countries. The Italian government will supply the buildings and the cost to other governments will be about $5,000 a year each.

The annual general meeting of the Royal Statistical Society was held on June 19 under the presidency of Major Craigie, C.B. Sir Richard Martin was elected president of the society for the ensuing session. The society's Guy medal in silver was awarded to Dr. W. N. Shaw, F.R.S., for his paper, entitled 'The Seasons in the British Isles since 1878,' read before the society in March, 1905. The subject of the essays for the Howard medal competition, 1906–7, was announced to be 'The Reformative Effect in Criminality of Recent Prison Administration.' This competition is open to the public. Professor Edgeworth afterwards read a paper on 'The Generalized Law of Error.'

We learn from *Nature* that at the seventy-eighth meeting of the Association of German Men of Science and Physicians, which will be held this year on September 16–22 in Stuttgart, there will be an exhibition of scientific and medical appliances and subjects as in previous years. The König Karls Hall of the Königlicher Landesgewerbemuseum has been set apart for the purpose. All announcements and communications may be addressed to the president of the exhibition committee, Dr. Lampert, Archivstrasse 3, Stuttgart, from whom further particulars may be obtained.

A correspondent of the London *Times* writes from Si-ning, in the province of Kan-

su, under date of April 6: "Dr. Albert Tafel, the eminent German geologist and explorer, who has traveled in many parts of Asia, and who took part in the expedition to Tibet in 1904 with Lieutenant Filchreer, when they barely escaped with their lives, has again just left this border city for the Tsaidam and Tibet. In January last he visited the Koko Nor in order to ascertain the depths of the lake at different places. His camp was attacked one evening by Tibetan robbers, and a hand-to-hand fight ensued. In trying to rescue one of his men Dr. Tafel received a sword wound in the forehead, and the attack was not repulsed without some difficulty. In Shan-si Dr. Tafel found some very interesting and rare fossils, and he has also secured some good photographs of a large waterfall on the Yellow River in the north of that province."

Nature states that the Society of German Engineers, which with its 20,000 members is now the largest technical society in the world, celebrated on June 11–14 the completion of the fiftieth year of its existence. The opening ceremony was held in the Reichstag building in Berlin, under the presidency of Dr. A. Slaby. Congratulatory addresses were delivered by the Prussian Home Secretary, the Prussian Minister of Education, the Oberbürgermeister of Berlin and the rector of the Berlin Technical School, as well as by numerous representatives of kindred societies in Germany and other countries, Mr. Bennet Brough (Iron and Steel Institute) speaking for the British societies and Professor K. E. Hilgard (American Society of Civil Engineers) for the American. The proceedings terminated with a lecture by Dr. W. von Oechelhauser on technical work past and present, in which he compared the engineering works of the ancients with those of modern times, and endeavored to forecast what the future of engineering would be. On June 12 a lecture was given by Dr. A. Riedler, on the development and present importance of the steam turbine; and on June 13 papers were read by Professor Muthmann, on methods of dealing with atmospheric nitrogen; and by Dr. Hoffmann, on the utilization of power in mines and metallurgical works. Throughout the week an elaborate program of visits, excursions and social functions was arranged for the 1,231 members and 464 ladies who took part in the meeting. The German Emperor honored the society by accepting the Grashof gold medal, and by conferring decorations on the president and other prominent members. An interesting history of the society is given in *Engineering* of June 8. The growth of the society has certainly been remarkable. It was founded in 1856 at Alexisbad, in the Hartz, by twenty-three young engineers. Friedrich Euler was elected the first president, and Franz Grashof the first secretary and editor, the work of the society being carried on in the secretary's private study. The society now has a stately house of its own and a staff of forty-seven officials. Its weekly journal last year cost £26,162 for publishing and £6,425 for postage.

UNIVERSITY AND EDUCATIONAL NEWS.

AT the recent alumni meeting at Harvard University, it was stated that during the year graduates had contributed $1,801,539.89 to the productive funds of the university, and that $88,116.09 had been received for immediate use, making a total of $1,889,655.98. This sum does not include the more than $113,000 that the class of '81 has given to the university to be used as the corporation sees fit. It was also announced that through an anonymous gift of $60,000 from a graduate and the cooperation of the city of Boston, a boulevard 100 feet wide with a forty-foot drive and broad park space and walks, will be laid out from the Fenway to Longwood Avenue as an approach to the new Harvard Medical School buildings.

IT was announced by President Hadley at the Yale Alumni dinner that the total of the alumni fund for the year amounted to $129,237 as compared with the $53,500 announced a year ago.

A FUND of $150,000, of which Mr. Carnegie contributed $75,000, has been raised at Amherst College and will be used to provide for the work in geology and biology. It is planned to spend $100,000 on a building and to use the balance of the money as an endowment fund.

At the Radcliffe College commencement President Briggs announced that the requisite sum of $75,000 to secure Mr. Andrew Carnegie's gift for a college library had been secured.

Mrs. Louisa N. Bullard has given Harvard University Medical School $52,000 to establish a chair of neuropathology.

We learn from the *Journal of the American Medical Association* that the University of California has transferred from San Francisco to Berkeley all instruction in the first two years of the college of medicine. Students desiring admission to the medical department of the university must have completed certain studies in physics, chemistry, zoology, German and French, which ordinarily require two years of residence at a university or college of good standing. The first two years of the strictly professional work is devoted to anatomy, physiology and pathology. As heretofore, the work of the last two years of the medical course will be carried on in San Francisco.

Foreign papers state that the council of the University of Paris has definitely approved of the scheme for the extension of the university. This will include the construction of an institute of chemistry covering an area of 9,000 square meters. Here will be established the various departments of chemistry belonging to the faculty of science and the department of applied chemistry which, since its creation, have been provisionally installed in some sheds. The cost of this will be 3,000,000 francs, which will be divided between the city of Paris and the state. The extension scheme also includes the acquisition by the university, in view of future necessities, of a plot of land of 14,000 square meters. Towards the cost of this land the university will pay 1,900,000 francs and the city 700,000 francs, to which will be added the donation from the Prince of Monaco. On a portion of this area will be erected the Institute of Oceanography, founded by the Prince of Monaco.

At the meeting of the University Court of Edinburgh on June 17 an addition was made to the teaching staff of the university by the establishment of an independent lectureship in general and experimental psychology in connection with the philosophical department. The funds for the lecturer's salary are mainly supplied by the Combe trustees, who have also contributed £300 towards the equipment of a laboratory. In consideration of this generous assistance the court resolved that the lectureship should be called the George Combe lectureship. George Combe, known as the author of 'The Constitution of Man,' was the chief representative of phrenology in Great Britain in the first half of last century. He left funds, which have considerably increased since his death, for promoting the knowledge of man's mental and organic constitution in relation to the external universe and its laws, and for diffusing that knowledge as widely as possible. Besides experimental teaching and research, it is expected that the lectureship will be largely utilized in connection with the training of teachers. An appointment will be made in time for work to begin next session.

Dr. G. H. Parker has been promoted to a full professorship of zoology at Harvard University.

Professor Edward Octavius Sisson, Ph.D., who has recently been elected head of the department of education in the University of Washington, is a native of England. He received his education in schools of this country. In 1886 he received the degree of bachelor of science in the Kansas Agricultural College. From 1886–91 he was teacher and principal in public schools.

Dr. Valdemar Koch has been appointed to the chair of physiological chemistry in the University of Chicago.

At Bowdoin College, Dr. Walter T. Tobie, of Portland, has been elected professor of anatomy and Dr. Thomas J. Burrage, also of Portland, assistant demonstrator of histology.

Dr. George A. Falkiner Nuttall, F.R.S., has been appointed reader in hygiene for five years in Cambridge University.

Professor Hans Chairi, of Prague, has been appointed professor of pathology in the University of Strasburg as successor to Professor von Recklinghausen.

SCIENCE

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FRIDAY, JULY 13, 1906.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. ITHACA, N. Y., JUNE 28 TO JULY 3, 1906.

REPORT OF THE GENERAL SECRETARY.

THE fifty-sixth meeting of the American Association for the Advancement of Science was held at Ithaca, New York, June 28–July 3, 1906. This meeting was peculiar in being an extra meeting in the summer, the winter meeting at New Orleans having been held only six months before, and a winter meeting being planned for New York six months later. As a consequence of the fact that it was an extra meeting, there were no presidential addresses, no election of officers, except to fill vacancies, and there was but little action of any kind taken by the council.

The registered attendance of the association members was 232, and 94 members of the American Chemical Society were known to be present who were not registered as members of the association, making a clearly ascertained total attendance of 326. Other information, derived from the registration of four affiliated societies, indicates that the total attendance was about 400. As to attendance, the meeting was intermediate between the two meetings next preceding, namely, at New Orleans and at Philadelphia.

The following table shows the registered attendance by sections, and the affiliated societies which met at Ithaca:

Section A, 1. (No meeting of section was held.)

Section B, 50. American Physical Society.

Section C, 45. American Chemical Society and the New York Chapter of the Society for Chemical Industry.

Section D, 23. Society for the Promotion of Engineering Education.

Section E, 14.

Section F, 42. American Microscopical Society.

Section G, 30.

Section H, 6. (No meeting of the section was held.)

Section I, 14.

Section K, 3. (No meeting of the section was held.)

Four persons registered indicated no preference as to section.

Section B and the American Physical Society had a joint program of 29 papers, in which no distinction was made between the papers furnished by the two organizations, the papers being arranged according to topics.

Section C held no formal meeting. Its secretary aided the representatives of the American Chemical Society in preparing the program of their Ithaca meeting, and in making preparations for a joint meeting in New York. This society had a program of more than 80 papers, and its meetings were divided into sections.

The chemists constituted about one third of the total attendance at Ithaca. The chemists and physicists together constituted about one half of the total attendance.

It is interesting to note further that of the 231 members of the association registered, about one half, or 121 to be exact, are members of the affiliated societies meeting at this time and place.

The geographical distribution of the members in attendance can be computed only for the 231 registered members of the association; of these, 94 come from New York State; 20 from Massachusetts; 17 from Pennsylvania; 16 from the District of Columbia; 12 from Ohio; 10 from Illinois; 7 from Michigan; 5 from Indiana; 5 from New Jersey; 4 from Canada, Kentucky and California; 3 from New Hampshire, Minnesota, Missouri, Connecticut and Virginia; 2 from Iowa, Nebraska and Maryland; and 1 each from Tennessee, North Carolina, Alabama, South Carolina, Mississippi, Vermont, Rhode Island, Wisconsin and Kansas.

The meetings of Section D were held on Friday and Saturday. They were followed by those of the Society for the Promotion of Engineering Education in the same room on Monday and Tuesday, with an attendance about 50 per cent. greater than that of Section D.

Section E held two sessions on one day for the reading of papers, and devoted the remaining three days to excursions to points of interest from a geological point of view, near the northern end of Cayuga Lake, near the southern end of Cayuga Lake and at Enfield Glen.

Section F and the American Microscopical Society had a joint program.

Section G spent two and a half days in excursions to points of special interest from the botanical point of view, including a visit to Enfield Gorge. One day was spent in informal discussion of matters observed on the excursions. The Fern Chapter and the Society for Horticultural Science met at Ithaca just before the meeting of the association.

The attendance at the meetings of Section I was 25 to 40, considerably in excess of the registered number of members of that section (14). Nineteen papers were presented.

The relations between sections and affiliated societies were entirely harmonious in every case, the officers cooperating cordially in a common cause.

Cornell University placed its buildings at the disposal of the association, and each

day furnished a mid-day lunch to the members. An appropriate resolution of thanks was adopted.

The following general events added greatly to the meeting:

1. The informal smoker at the Town and Gown Club on Thursday evening.

2. The formal opening and dedication of Rockefeller Hall, the magnificent new Physical Laboratory of Cornell University, on Friday afternoon, with short addresses by President J. G. Schurman, Professor E. L. Nichols, Dr. Elihu Thomson, Dr. W. H. Welch (the president of the association) and a letter from Professor W. A. Anthony, read by Professor E. Merritt.

3. An address on Saturday evening by Professor Henry S. Carhart, of the University of Michigan, on 'The South African Meeting of the British Association for the Advancement of Science,' illustrated by a most excellent series of lantern slides.

4. A reception on Monday afternoon by Dr. and Mrs. Andrew D. White at their residence on East Avenue.

5. A public address on the recent California earthquake by Professor J. C. Branner, vice-president of Stanford University, given under the auspices of the local chapter of Sigma Xi in commemoration of the twentieth anniversary of the founding of the society. This was immediately followed by a Sigma Xi banquet, which was largely attended.

There were during the meeting, both within and outside of the council, various discussions of the relations of the association and of the affiliated societies. The only resolutions passed by the council bearing directly upon this matter follow:

Resolved, That the secretary of each section be required to prepare for the New York meeting a program of general interest for at least one session of his section.

Resolved, That the secretaries of the sections be requested to confer with each other, and with the secretaries of affiliated societies, regarding the relation of programs for the New York meeting, and

Further, That the sectional committees be empowered to turn over technical papers to the technical societies, and

On motion, the permanent secretary was instructed to prepare a list of members of the association who belong to the affiliated societies accepted as possessing proper qualifications, and to submit these names to the council at the New York meeting, with the recommendation that they be elected as fellows.

The social features of the meeting were unusually pleasant; and, although there was no central rallying point for all the scientific people in attendance, except the luncheon place at 1 o'clock, the opportunities for social converse were many.

The Ithaca meeting will be remembered by those who attended it as one of moderate size, thoroughly successful as to number and quality of papers presented, characterized throughout by harmonious relations, especially notable for pleasant and profitable excursions, and given a tone of peculiar charm by scenic surroundings unrivaled by those of any other college campus in the United States.

The addresses made at the opening general session in Barnes Hall on Friday, June 28, are appended to this report.

JOHN F. HAYFORD,
General Secretary.

The first general session of the association was held in Barnes Hall, Cornell University, at 10 o'clock on Friday morning, June 29, 1906. The president of the association, Dr. William H. Welch, after calling the meeting to order, introduced Dr. J. G. Schurman, president of Cornell University, who delivered the following address of welcome:

Ladies and Gentlemen: I have very

much pleasure, on behalf of the university under whose auspices you meet, to extend a cordial welcome to the members of the American Association for the Advancement of Science, to the affiliated societies and to the friends who accompany them here. We feel it a great honor to have under our roof so large a gathering of distinguished scientists from all parts of the country.

I notice that you have timed your meetings so that you may be home by the Fourth of July to properly celebrate that day. I was thinking that if you practised on this occasion the scientific habit of analysis, and asked yourselves what was especially worthy of celebration in the day, you would perhaps sum it up under two or three heads. One of them undoubtedly would be the fact of a great nation of freemen governing themselves. The second, I think, would be the splendid mechanisms for the production and transportation of economic commodities which this republic has developed since the first Declaration of Independence. And I think the third would be the unusually high level of material comfort which the great majority of our population enjoy. You see I have made a close connection between the third of July and the fourth. If I am right in the analysis I have made, and have described correctly the three most important things that this republic has to celebrate as each fourth of July returns, we can recognize that two of them, at least, are the results of the labors of scientists. We can not, perhaps, attribute to scientists a larger share than we attribute to other citizens in the bringing out and maintaining of a free government, but if we have our splendid system of economic production, and if the tide of material comfort runs higher here than anywhere else on the globe, it is due, first of all, to the abundant resources of our country, and secondly to the discoveries and investigations for which scientific men are responsible. And when I say that scientific men have in this way helped to produce two out of the three most important things which characterize our own republic, I do not feel that I have exhausted their highest work, for science has during the last hundred years revolutionized the civilization of the world. It has in other countries, as in our own, increased material comforts, multiplied inventions and extended knowledge. It has introduced new modes of thought and new standards of evidence. The civilization of the earlier centuries was colored and molded by hearsay and tradition, whereas one of the most splendid achievements that has come to our age through the advance of science is the resting of knowledge on evidence, and on theory and hypothesis only as they are maintained by it. No one who has studied the thought and considered the progress of the world in its highest spiritual aspects can feel that I have stated the fact too strongly in saying that science has revolutionized the civilization of the past—first of all, that of Europe and of America, and later that of Asia also.

So, ladies and gentlemen, we at Cornell University feel it a great honor to have in our midst for a number of days the representatives of those men and women who by the achievements of their labors and intellects are really shaping the advance of nations and molding the civilization of mankind. I am not certain that we can adequately show you the honor which we feel. We labor under a certain disadvantage, for it is now vacation and many members of our faculty have left their homes, but what it was in our power to do we have done. We have placed the facilities of the university here freely at your disposal. Ithaca is not as well provided with hotels as some of the larger cities, and so to supplement our local resources in that regard we have opened Sage College, and the graduates and undergraduates who control

fraternity houses have also thrown them open. Our members will be ready, as the announcement explains, to take excursions to different parts of the surrounding country. We believe that we have here the most beautiful and most romantic college or university campus in the world. What lies in our power we are anxious to do. Our trustees have arranged for a luncheon to be served to you daily in the University Armory during your stay. I hope, Mr. President, you will not expect too much of us. We have done the most we could in the way of entertainment, and we hope you will accept the will for the larger deed which might have been possible in Washington, Baltimore or New York.

Ladies and gentlemen, once more I express the great pleasure we feel in having you with us, and in the name and on behalf of Cornell University I put what we have at your free disposal.

President Welch then introduced the Hon. Bradford Almy, mayor of Ithaca, who welcomed the association to the city in the following address:

Mr. President, and Ladies and Gentlemen: The people of this city rightfully feel that this is an important event with them. They feel that Cornell University, the institution in which they take so much pride, is the cause of their having the pleasure of your visit to our city at this time. That an organization so eminently distinguished as the American Association for the Advancement of Science, composed of individual leaders in thought, labor and achievement along all the lines that lead to the progress, welfare and happiness of our people, should assemble in Ithaca for their deliberations is a compliment which we sincerely appreciate and for which we are very glad.

The profound sense of gratitude which we all feel for the heroes, self-sacrificing in their labors as pioneers of science, who caused a ray of light to shine here and there in the utter darkness, may perhaps be a measure of the feelings which we have for you men and you women who are laboring along lines of work so persistently followed and so diligently wrought out for the benefit of mankind and the civilization of the world. We can all remember, for it was not so very long ago, when science and religion were believed to be at war with each other. That thought delayed its progress for a time, but science has made great advance during the years since that idea has left the minds of men. Happily, those times are past, and to-day science is regarded as more than the handmaid of religion. In bidding you the hearty welcome to our little city, which I have the honor and pleasure of extending to you on behalf of our people, I bid you Godspeed in the noblest work that can engage the thoughts and energies of mankind. At the same time, while we are conscious that the advancement in the last fifty years has been so great and so strengthens the courage and inspires the zeal for future work, we realize how diminutive are the regions of the known compared with the vast, untrodden wilderness on the border land of which you stand.

In closing, let me express the wish that you may have as prosperous a congress here as you have expected, that you may enjoy your visit as much as we hope you will and that you may go away with pleasant recollections of us and of Ithaca.

President Welch made response to the addresses of welcome, as follows:

Ladies and Gentlemen: In behalf of the members of the association, of our guests and all here present, I wish to express to you, President Schurman and Mayor Almy, our very cordial appreciation of the words of welcome which you have given us. This is the first meeting of the association in Ithaca. It is also a renewal of an old

custom of holding a midsummer meeting, and I do not know where that renewal, somewhat experimental, of the old custom could be inaugurated under more favorable conditions than in this place. Where could this association feel more at home than here at this home of learning and of science? It must, I think, be a satisfaction to the members at Cornell University to be enabled to show to their fellow members in this association the splendid opportunities which exist and the evidences of the great work done here, and it is equally a pleasure and source of profit to us to enjoy this privilege. We know that this is one of the great and leading universities of the country; that when it was founded Cornell University was enabled to do a work that was highly distinctive and significant and which marked a great advance in higher education in America, and that this position of leadership it has never lost. It is a great delight to come at this time of the year to this charming town and enjoy the wonderful beauties of nature in this region. They appeal not only to lovers of science, but to lovers of nature as well, and it would seem that the study of natural history must be stimulated by such surroundings as exist here. So, I say, we are particularly fortunate in coming to Ithaca and to Cornell University at this time.

The American Association for the Advancement of Science has had a very useful and honorable history. At the time it was founded and for many years afterward it was possible for a single association to represent in a very definite and concrete way all the existing natural and physical science in this country. During this period the scientific activities of the country were represented more adequately and comprehensively in this association than in any other body. But as time went on, science in its various branches extended and grew, conditions changed, and it became evident that it was necessary for the association to adjust itself to those new conditions, the main one being the specialization of scientific work. That specialization has been a great instrumentality in the progress of science throughout the world, but nevertheless it has certain disadvantages and even dangers of its own. I believe that the highest function of this association is to try to minimize to the greatest possible extent the dangers that may arise from the minute subdivision of scientific research. As its name implies, this association represents a central body for the advancement, and, it may be added, the diffusion and the organization of science in America. It may be at times a little burdensome for active workers in one department of science to feel interested in the central organization, but I conceive it to be their highest duty to do so. They should consider the interests of science as a whole in this country, as well as those of their particular branch of science, for unless the whole tree of science flourishes the branches will suffer.

This association represents, as it were, an association of various special scientific societies, perhaps more than an association of various scientific workers. It is necessary to have this coordination of societies in order to bring together the great body of scientific workers throughout the country, but in the plan of our organization the affiliated societies in no sense lose their autonomy and it is essential that they should not. The centers of scientific activity in this country are not concentrated in a few points, as in most European countries, and it is believed that this plan of organization best meets the special conditions of science in America.

It is very important, under our form of government, that there should be a central authoritative voice which speaks for science. How many questions there are, as has been suggested by President Schurman,

relating to the highest welfare of society which can be solved only by science, and how important it is that workers in kindred subjects should be brought into contact with each other! There are matters of education, matters of public policy and matters of research in all departments of the government and of national life that sustain very close relations to the opinions of scientific men, and it is, therefore, of first importance that there should be a body which can express in an authoritative and representative way the scientific opinion of the country.

This experiment of renewing the midsummer meeting indicates in a measure the great growth in membership and in influence of this association. In so doing, of course there is no intention of abandoning the meetings in the winter. It was necessary, in bringing about a proper adjustment of the work and aims of the association to the specialization of science as represented in the various affiliated societies, to adopt the plan of a winter meeting, but the association while gaining much undoubtedly lost something by it. Certain members, desirable to have with us, were unable to attend, and the more popular side of the work may have suffered somewhat because of the more special and technical character of the papers presented at the meetings in the winter. There are many, such as school teachers, amateurs and others intelligently interested in natural and physical science, but not actively engaged in research, whose support and interest it is desirable that the association should secure and who formerly attended the summer meetings. It is to be hoped that this effort to renew that kind of work and influence of the association which was expressed in the old days by the midsummer meeting will be successful and this extension of influence can be secured without any impairment of strictly scientific aims. As I have said, we certainly could not inaugurate the movement under better conditions than at this time and in this place.

This is the first opportunity that I have had to appear in my official capacity before the association, and I wish to express my appreciation of the distinguished honor which was conferred on me at the meeting in New Orleans. The honor is not merely a personal one, but I interpret it as a recognition of medical science as an integral, coordinate part of the natural science of this country; and medical science, in my judgment, fully merits this recognition on account of the paths which it has opened up and followed and the great advance which it has made in recent years.

President Schurman has indicated to us the intimate relations which science sustains to the highest interests of society throughout the world, and this condition has been brought about largely through scientific discoveries and their application to useful purposes. It is the glory of medicine that in these later days it has been able to contribute its share, a share not unworthy of its rank among the sciences of man and of nature, toward the advancement of useful knowledge. It has done so partly by recognizing the fact that a large part of medical science is essentially biological science, and that this is not only true of normal anatomy and physiology, but that pathology, the science of disordered structure and function, may be considered and cultivated to a large extent as biological science. This has been one of the reasons for the great advance in medicine. The scientific method, the method of observation, experiment and reasoning, in contrast with the dogmatism, speculation and reliance on authority which for centuries dominated the history of medicine, is recognized to-day by medicine as fully as by any science as the only source of fruitful progress.

But above all, it has been discoveries resulting from the opening up of new paths of investigation which have impressed both the scientific and the popular mind with the importance of medical science. In the last three decades medicine has advanced to a position where it stands as never before in the very closest relations to the highest interests of human society. When you consider the vast accumulations of population in cities, the great industrial activities of modern times, the efforts to colonize and to reclaim for civilization tropical countries and waste lands, such a stupendous undertaking as the digging of the Panama Canal, all dependent in a very direct manner upon our power to control the spread of epidemic and endemic diseases, and that this power has come from the discovery of parasitic microorganisms and the study of their properties and of the manner of propagation of agents of infection, it must be clear to you that medicine, especially preventive medicine, is most intimately related to the progress of civilization and the advancement of human society. So the time has fully come for medical science to stand side by side with other sciences and to be represented with them in this association.

I was expected on this occasion not to make a formal address but simply to reply to the cordial words of welcome which have been extended to us on behalf of the university and of the city. The evil day, fortunately for you and for me, seems by the plan of organization to be put far off, when the incoming president is expected to make his formal address to the association.

I now have pleasure in declaring this fifty-sixth session of the American Association for the Advancement of Science open, and I trust that the sessions of the association and the meetings of the several sections and affiliated societies will be full of interest and profit to all in attendance.

After announcements by the general, permanent and local secretaries, the general session of the association was adjourned.

JAMES MILLS PEIRCE.

One summer morning nearly forty years ago the boys who were to take their examinations for admission to Harvard College were assembling in Harvard Hall to meet the officer in charge of the examinations, Professor James Mills Peirce. As the room filled he walked slowly up and down the platform, his hands clasped behind his back in a manner very familiar to all his friends, looking now at the boys, now out of a window, but saying not a word. One of the boys, now himself a professor in the university, leaning over, whispered in Greek to his friend an adapted line of Homer—'Behold him as he walks, the shortest of them all, but kingliest of men.' Such was the impression made then and always by James Peirce on those who were fortunate enough to meet and know him. It is the purpose of the following sketch to give some account of his life together with a short description of the changes which, during his fifty years of service, took place in Harvard University.

James Mills Peirce was born in Cambridge on May 1, 1834. He was the son of Benjamin Peirce, the great mathematician, and Sarah Mills Peirce. The father of Benjamin Peirce, also named Benjamin, was librarian and the first historian of Harvard College. James Peirce's maternal grandfather was a representative in congress, later senator from Massachusetts, and a colleague of Daniel Webster. James Peirce graduated from Harvard College in 1853. The next year he spent at the Law School. In 1854 he gave up the study of law to become a tutor in mathematics in Harvard College. In 1857 he entered the Divinity School, retaining his position as

tutor, however, until 1858. After graduating in 1859 from the Divinity School, he spent the next two years preaching in the Unitarian churches in New Bedford, Mass., and in Charleston, S. C. In 1861 he gave up the ministry to return to Harvard as assistant professor of mathematics, and remained in the service of the university until his death. In 1869 he was made professor of mathematics, and in 1885 appointed to the Perkins professorship of mathematics and astronomy. He served as secretary of the Academic Council from its establishment in 1872 until 1889, as dean of the graduate school from its foundation in 1890 until 1895, and as dean of the faculty of arts and sciences from 1895 until 1898. His resignation from the faculty, to take effect in March, 1907, on the completion of fifty years' service as a teacher in the university, was accepted by the president and fellows only a few weeks before his death. He died suddenly of pneumonia on March 21, 1906, in the seventy-second year of his life and in the fiftieth year of his service as a teacher in the university. It is a curious coincidence that his father also died in the seventy-second year of his life and in the fiftieth of his service in the university.

The period from 1860 to 1880 was a time of great changes in the university, the development of the elective system, and the beginning of the graduate school. With these changes James Peirce had much to do. It may justly be said that the great work of his life was the development of graduate instruction in Harvard University. Accordingly I purpose to give some account of the condition of the mathematical instruction at Harvard at the beginning of his academic career, and to show by following its development the growth of the elective system, the beginning of graduate instruction, and to trace, as far as possible, his influence in this period of transition.

In 1853 when he graduated from college the mathematical instruction was given by his father, Professor Benjamin Peirce, and by a single tutor, Mr. C. F. Choate. The course consisted of required freshman work in plane and solid geometry, algebra and plane trigonometry; of required sophomore work in algebra, spherical trigonometry and analytic geometry; of elective courses for juniors and seniors in 'imaginary, integral and residual calculus,' in mechanics, and in astronomy. All college work in the freshman and sophomore years, and in the junior and senior years three fifths of the work, was required. The elective system, though undeveloped, had already had its beginning. About 1849 this small privilege of election was in danger of being withdrawn by the faculty; at one time a majority of this body actually favored making the whole course required. The elective system was saved at that time by the determined fight of a few liberal-minded men, prominent among whom was Benjamin Peirce.

In 1854 Tutor Choate resigned and in his place James Peirce was appointed. In the same year his classmate, Charles W. Eliot, was also appointed tutor in mathematics, the teaching force of the department being thus increased to three. The tutors hereafter carried on the freshman and sophomore work, leaving Professor Benjamin Peirce free for more advanced work. James Peirce, having the first appointment, had the choice between freshman and sophomore work. With a modesty which always characterized him, he decided to teach the freshmen, believing himself not so well qualified to give the sophomore instruction as to teach the more elementary freshman subjects.

At this time examinations in all college

courses were conducted orally by the instructors acting with examining committees appointed by the overseers. These examinations, far from being severe, were in some cases almost farcical. Some professors held rehearsals of the examinations prior to the visits of the overseers' committees; others gave the examinations in such a manner that a student might without difficulty discover just what question would be asked him, and prepare himself accordingly. Furthermore, the time for examining a student on one subject could not be extended beyond two or three minutes. It may be imagined that the passing of examinations was not a difficult matter. Indeed, it was not necessary for a student to pass even these examinations. For the faculty could not be prevailed upon to refuse its degree to a student, however bad his scholarship, if his conduct during his residence at the university had not incurred serious censure. It happened once in the early fifties that the faculty was almost persuaded not to vote a degree to a student of greater than usual incapacity, when it was discovered that the candidate had not once during his four years absented himself from prayers. The degree was granted without further debate.

Tutors Peirce and Eliot, dissatisfied with these oral examinations, introduced, during their first year, occasional written hour examinations in place of the regular recitations. These examinations were used by the instructors in making their reports, but did not replace the annual oral examination held in the presence of the overseer's committees. Other instructors, notably the teachers of the classics, followed the lead of the mathematical department. This new system of examination, requiring real knowledge on the part of the student, proved disastrous to the lazy and incompetent, and though bad reports of a student's scholarship did not at first prevent his obtaining a degree, the results soon made evident the impracticability of requiring every man to do the same work. There was resistance on the part of both faculty and overseers to the introduction of written examinations, and a still greater resistance to the abandonment of a system of required studies. But before very long even the most conservative members of the faculty were forced to admit that the real examination must be a written one. At a conference held by committees of the faculty and overseers were passed five resolutions concerning examinations, which were unanimously adopted by the faculty on March 9, 1857. Of these resolutions the most important were the following:

1. Examinations in all courses shall be annual and in writing.

2. All marking shall be done by the instructors.

3. All examinations shall be prepared and printed by the instructors, and shall be submitted to the several (overseers') committees previous to the examinations.

The introduction of written examinations was largely due to James Peirce and Charles W. Eliot. It made apparent the necessity of giving students a greater field of choice in their studies, but it did not by any means bring with it the modern elective system. For the next ten years, almost to the time when Mr. Eliot became president of the university, there was in the faculty a struggle between the advocates and the opponents of the elective system. The faculty at that time consisted of about fifteen members. The younger members and one or two of the elder ones were in favor of giving the college the elective system. But not till 1868 was any change made in the required mathematics for freshman and sophomores. For the first time in the academic year 1868–69 sopho-

mores were not required to study mathematics. Under the administration of President Eliot the elective system developed rapidly, but no further change in the mathematical requirement appears until 1884, when the freshman requirement was dropped. From the autumn of that year the study of mathematics in Harvard College has been wholly elective. Just what part James Peirce played in the development of the elective system is uncertain. He was active always for the freeing of students from restrictions, and for any movement which seemed to him likely to promote true scholarship. He was an advocate of the elective system, and was always, in the faculty, a staunch supporter of every step in the direction of greater liberty to the student.

He was absent from Cambridge from 1859 to 1861. In 1861 he returned to the university as assistant professor of mathematics. In the previous year Mr. Eliot had been made assistant professor of mathematics, but in this year he was called to take charge of the work of the scientific school. The mathematical teachers in Harvard College were then Professor Benjamin Peirce, James Peirce and a single tutor, Solomon Lincoln. In the courses of instruction offered in that year the only change from the list of 1853 is the addition of an elective in quaternions, given by the elder Peirce.

In 1863, at the request of a number of professors, the corporation ordered that—

> The president, with the (full) professors in all departments of the university, be authorized to meet and associate themselves in one body for the consideration of its educational interests, and for the arrangement of such courses of lectures as may be thought expedient for the benefit of the members of the professional schools, graduates of this or other colleges, teachers of the public schools of the commonwealth, and other persons.

This body was known as the university senate. The establishment of the senate laid the foundation of the graduate school, in the development of which James Peirce, though not a member of the senate, played a prominent part. This body instituted various courses of 'university lectures,' including, in the words of James Peirce, 'many of high value and interest in all departments of learning.' These courses were generally short, consisting each of not more than five or six lectures. In 1863–4, the first year of the lectures, three courses were given on mathematical subjects: 'The Theory of Space developed by Quaternions' and 'The Connection of the Physical and Mathematical Sciences,' by Benjamin Peirce, and 'Special Investigations in Dynamics,' by William Watson. In the following year these courses were repeated with the addition of a fourth on 'Determinants' by James Oliver. Apparently the courses in mathematics did not meet with a very cordial reception, for in the third year only one mathematical course was offered, 'The Development of the Universe,' by Benjamin Peirce. Indeed, it may be supposed that this course was philosophical as much as mathematical. In 1866–7 this course was repeated, and Thomas Hill, the president of the university, gave courses on 'Methods of Teaching Elementary Mathematics,' and on 'A Constant Product.' In 1867–8 Benjamin Peirce gave for the first time a course of university lectures on 'Linear Calculus.' It is probable that this course dealt with the linear associative algebras invented and developed by him. In that year James Oliver gave a course on 'Geometry of Three Dimensions.' In the following year there were no courses of university lectures in mathematics, but in the catalogue of the scientific school, which was at that time an institution especially intended for advanced study and research, is printed this note: 'Private instruction in the various branches

of mathematics will be given to those desirous of receiving it by competent instructors residing at the university.' These instructors were Professor Benjamin and James Peirce.

In the autumn of 1869 Charles W. Eliot became president of the university, and at once occupied himself with the development of the advanced instruction. Various short courses in related subjects were combined; many new and longer courses were offered. To quote again the words of James Peirce, 'a settled purpose was manifested to establish the instruction of advanced special students on a permanent and efficient footing.' In addition to certain university lectures there were offered that year two 'university courses of instruction,' one in philosophy and one in modern literature, each consisting of three lectures a week throughout the year, and each given by several instructors. The university lectures in mathematics were 'Linear Algebra,' thirty-five lectures by Benjamin Peirce; 'Algebraic, Periodic and Double Periodic Functions,' thirty-five lectures, and 'Higher Geometry,' eighteen lectures by James Peirce. This was the first year in which James Peirce gave university lectures. It was, too, the first time that any branch of the theory of functions was taught at Harvard. In this year the regular elective courses in mathematics were greatly increased in number, and James Peirce was then and thereafter entirely freed from giving freshman instruction. He taught that year four elective courses, each of two hours a week, on analytic geometry, differential calculus, integral calculus and elementary mechanics. Four electives were offered also by his father, consisting each of from one to three lectures a week, on mechanics, astronomy, quaternions and linear algebra.

During the next ten years there were no important changes made in the regular courses offered in mathematics. Benjamin Peirce, who was in 1869 sixty years of age, withdrew somewhat from active academic work, giving after 1870 not more than two courses a year, those generally on 'Quaternions, Mechanics and Linear Algebras.' The teaching of the elective courses was taken over almost wholly by James Peirce. He gave a great variety of courses, usually giving about twelve lectures a week. In 1870–1 he gave for the first time a regular course on 'The Theory of Functions,' in 1874–5 a course on 'Elliptic Functions,' in 1876–7 a course on the 'Functions of a Complex Variable,' following Briot and Bouquet. In 1878–9 he gave for the first time an elementary course on quaternions, his father giving the second course. In the following year James Peirce gave the advanced course, his father giving the first course. This plan of giving courses of two years on one subject, with two instructors alternating, has since that time been often followed at Harvard.

In 1870–1 the mathematical university lectures consisted of two courses, one on 'Celestial Mechanics,' two lectures a week for half the year by Benjamin Peirce, and a course of the same length on 'Modern Methods in Geometry' by James Peirce. The latter course has now become a fixture in the elective courses given every year, and, under the name of mathematics 3, is known to almost all students of mathematics who have been at Harvard during the last thirty years. In this year the number of courses of university lectures offered was thirty-three. The number of persons recorded in the catalogue as attending them is twenty-six.

Whether or not on account of the small attendance, it was found that the university lecture system was not satisfactory, and in 1872 these lectures were abandoned.

The university senate was reorganized as the academic council. The new body consisted of all professors, assistant professors and adjunct professors in all departments of the university. The degrees of Ph.D. and S.D. were instituted. The principal functions of the academic council were the administration of these degrees and the degree of A.M., and the superintendence of the advanced instruction. James Peirce was elected secretary of the council at the first meeting and continued to hold this position until 1889, when the chief functions of the body were transferred to the administrative board of the graduate school. In this capacity he practically had charge of the graduate instruction. He was behind every movement for giving the student greater privileges, as he was in favor of every change calculated to improve the quality or to raise the standard of instruction. In 1873–4 there were at the university forty candidates for the higher degrees. In 1894–5, the last year of his official connection with the graduate school, there were 255 resident graduate students, and 17 non-resident graduate students. The courses intended for advanced students were after 1872 regular elective courses and appear in the catalogue with the other electives. In the catalogue for 1875–6 appears for the first time a separate list of courses, twenty-five in number, intended especially for graduate students. In 1894–5 there were given 77½ courses intended primarily for graduates, 101½ intended for graduates and undergraduates. The development of the graduate instruction from 1872 to 1895 was steady but marked by no striking change. Of interest in this connection are the closing words of the last report made to the president of the university by James Peirce as dean of the graduate school. He writes in 1895:

> I account it a high privilege that I have held the position of executive officer of our graduate department since it was first established in January, 1872. I have seen it struggle for years against the coldness and scepticism of many members of our own faculty and against untoward conditions in its constitution and in outward circumstances; and I now have the happiness of beholding it the acknowledged representative of the best culture, the most advanced science and the highest liberal learning of the university. I am fully conscious that I can claim nothing for myself in this progress, beyond a faithful service and an earnest endeavor to rivet attention to the highest ideals of intellectual work as furnishing the only true basis of the development of such a school. The graduate school is a genuine outgrowth of the demands of a generation of students now coming forward in America; and it is destined within a few years, as I confidently believe, to an expansion which will make its present prosperity look small. To this university it is already rapidly becoming the much needed regenerator of the motives and principles of student life; the open door which is admitting to us a national constituency; the western window letting in a flood of warmth and light to dissolve academic selfishness and narrowness, and to quicken us in the discharge of our highest duty, that of devotion to the service of our country and our time. When its own relations to the college proper have been satisfactorily established, through a wise readjustment of the grounds of our several degrees, it will gather into one bright focus the influence and authority of the scholarship of this university, and will carry on the name of Harvard to be still a conspicuous symbol of light and power to the coming century, as it has been to that which is nearing its close.

From the time of his father's death, in 1880, James Peirce was at the head of the mathematical instruction of the university. At the beginning of his service the teaching force was composed of one professor and two tutors; at the time of his death there were in the department of mathematics five professors, one assistant professor and two instructors. In 1854 the instruction offered embraced the required elementary freshman and sophomore work, and three elective courses. In 1905–6

there were offered five and a half courses primarily for undergraduates, of which two are of as advanced a nature as the electives offered in 1854; six courses intended for graduates and undergraduates; seven and a half courses of lectures primarily for graduates, and six courses of reading and research; in addition many other courses are named and described in the catalogue which are to be given in following years. As chairman of his department James Peirce was a most liberal-minded and conscientious administrator. He favored always the introduction of new courses, he was always desirous that the younger teachers should have an opportunity to give advanced instruction, he was scrupulously careful and painstaking in the details of administrative work. He seldom tried to impress his own opinion on the department, but preferred to be guided by the wish of the majority.

He gave himself a great variety of courses. Although his chief interest lay along the lines followed by his father, quaternions and other linear associative algebras, he was also much interested in geometry and in mechanics. In 1904–5 he returned to the teaching of mechanics after having laid the subject aside for many years. The course in which he is best known to the present generation of students are the two courses on 'Quaternions,' mathematics 6 and 9, and courses on 'Algebraic Curves and Surfaces,' mathematics *7a*, *7b* and *7c*. These courses were well attended, especially those on 'Quaternions,' the number of students in mathematics 6 ranging from ten to twenty-five. He gave usually a course or two half courses each year, to a small number of students, on 'Linear Associative Algebras' or on the 'Algebra of Logic.' He never fell into the narrowing habit of giving year after year the same courses, but was eager always to undertake the teaching of some new branch of mathematics. In the last year of his life he gave a new half-course, an 'Introduction to Higher Plane Curves,' to serve as a preparation for his other courses on that topic. Indeed, so anxious was he to avoid falling into a rut that he made very slight notes for his lectures, preferring, in repeating a course, to work it out anew. This method resulted in a continual freshness and variety of presentation in his teaching. His courses were conducted by lectures, but his students had always opportunity for questions and discussion. His lectures were extremely clear and excellent in form. He loved to develop a subject with great generality without, however, sacrificing detail. In his courses he covered the ground slowly, and a younger generation of students have occasionally felt some impatience with his very careful and methodical discussions. He was not a great believer in the 'problem method' of teaching and he gave almost no home-work to his students. He was a mathematician of wide and varied learning. His life was given to his teaching, and to administrative work, rather than to research. He published little. In 1857, at the age of twenty-three, he published an 'Analytic Geometry,' based on a part of his father's famous work called 'Curves and Functions.' This 'Analytic Geometry' was used for many years as a text-book at Harvard, and was considered an admirable treatise. Of it Joseph Henry Allen, writing in the Harvard Register in 1881, says: 'I call (it) the very best text-book I ever used, and I never cease to bewail (that it) has gone out of print if not out of use.' This book, of 228 pages, contains a development of the elements of the subject with the usual applications to the study of conic sections. Written in a very attractive style, it is much more interesting reading, though it

would, perhaps, not be so useful in the class-room, than the modern text-book. It contains some explanation of the applications of conic sections to physical problems, and some sections which are in the author's own words 'speculative.' In 1873 he published a book of 83 pages on 'The Elements of Logarithms'; in 1888 a pamphlet of 67 pages called 'An Outline of the Elements of Analytic Geometry.' This is something more than a syllabus; it is rather a summary of the principles of the subject with short explanations. He published several books of mathematical tables, of which the last, 'Mathematical Tables Chiefly to Four Figures,' was published in 1879. These tables are well arranged and are widely used. He wrote few articles for scientific periodicals, the last one being 'On Certain Systems of Quaternion Expressions and on the Removal of Metric Limitations from the Calculus of Quaternions,' printed in the *Transactions of the American Mathematical Society* for October, 1904. He was the author of a few other short articles, one of which is 'A Rule Relating to the Calendar,' which appeared in the *Harvard Register* in 1881. He edited in 1881 a course of Lowell lectures given in 1877–8 by his father, to which he added certain appendices. In the course of his administrative work he wrote, as dean of the graduate school and as dean of the faculty, numerous reports to the president of the university, remarkable for their clearness and even more so for the richness and dignity of his style.

Professor Peirce was interested always in the social side of mathematics. When he began to teach at Harvard there was a mathematical club which held weekly meetings during the term in the lecture room of Professor Benjamin Peirce in University Hall. The club was small and not confined to members of the university. At the meetings James Peirce sometimes spoke. In later years a 'Mathematical Conference,' established by the department, has held fortnightly or monthly meetings, at which papers were presented by the students and, less often, by members of the teaching force. James Peirce was usually present at these meetings, attending them probably oftener than any other member of the faculty. Once or twice he presented papers, among the last, one of great interest on the history of mathematical teaching in Harvard University. Two years ago these conferences were discontinued, and were replaced by a mathematical club to which belonged both the teachers and the students of mathematics. In this club, too, Professor Peirce took the greatest interest, and at its first meeting read a paper on 'The Analytic Geometry of Descartes.'

In 1881 was founded by the teachers of mathematics and physics of Harvard and of the Massachusetts Institute of Technology a club known as the M. P. Club, the purpose of which was to bring together the teachers and advanced students of these subjects at both institutions as well as other people interested, to hear and discuss short papers, and to provide pleasant social intercourse. James Peirce was elected its president, and continued to serve in this office until his death. He gave the club much thought and time, and took a deep interest in its welfare. One meeting each year was usually held at his house and that meeting was generally the pleasantest of the year. Of late years he felt that he had served too long as the club's president, and on several occasions offered his resignation, but in his own phrase, he always returned to his home 'unresigned.' He was a very regular attendant and a most modest and charming presiding officer. The first subject discussed by this club was 'Can there be a discontinuous

function?' It was voted after debate that no discontinuous function exists.

At the time of his last illness plans had already been made for an anniversary dinner of the club, at which a loving cup was to have been presented to him as a token of the appreciation, felt by the members, of his quarter century of service as president.

No man could have been more closely identified with Harvard University than was James Mills Peirce. Born and educated in Cambridge, he spent there nearly every winter of his life. From the time of his entrance into Harvard College as a freshman in 1849 until the death of his father in 1880 he lived in the college yard as student, tutor and professor.

He was a man of most sweet and friendly disposition, kind to all with whom he came in contact, slow to anger, aroused only by injustice; a man of wide acquaintance and of many friends, most hospitable in his own home, fond of society and given to sociability. A lover of music and widely read in English literature, he was a man of the broadest intellectual interests.

What marked him most was a great faithfulness. He never faltered in his work, he never lost interest, indeed his enthusiasm grew greater from year to year. The welfare and the usefulness of the university were his dearest concern, and for their advancement was given the whole of a long and active life. He died, as we must suppose he would have chosen to die, working to the end.

J. K. Whittemore.

Harvard University.

Discussion and Correspondence.

Northern limit of the papaw tree.

Some years ago I was surprised to receive from a correspondent, Mr. Kennyon, of McGregor, Ia., a specimen of the papaw tree found native in the vicinity of McGregor. Below McGregor on the Mississippi, between Dubuque and Specht's Ferry, quite a number of specimens of this plant were observed. Some years later, while botanizing in the vicinity of Clinton, Ia., the species was found in flower. I have never seen any fruit at any point near here, but feel warranted in saying that the plants are perfectly hardy and do bear fruit. In all of these cases the plants were found growing on the sides of limestone hills. It may be of interest also to note in this connection that the pecan also occurs on the Mississippi at Savannah, Ill., which is somewhat north of the latitude usually given for it. While it is true that the Indian may have been an agent in the dissemination of the seed of the papaw, it was probably also disseminated in other ways.

L. H. Pammel.

The crayfish industry.

In my recent article on 'The Future of the Crayfish Industry,' in Science, June 29, two errors appear on page 984. The value $420 in line fourteen should be $4,200 and the amount of 165,000 in line twenty-two should be 116,400, as *correctly* stated in the statistics of the Bureau of Fisheries.

E. A. Andrews.

Special Articles.

Emission of electricity from the radium products.[1]

Hitherto, the rate of decay of the induced activity produced by radium, has not been studied by means of the charge carried away from the active body by the α and β rays.

The following is a brief report of the results of two series of experiments on the charge of electricity carried by these rays.

In the first series of experiments, a metal wire was made active by immersion in radium emanation; and immediately after removal from the emanation vessel, was placed inside a small hard rubber tube, with very thin walls. The outside of the tube was surrounded by

[1] An abstract of a paper read before a meeting of scientists, at the University of Colorado, on May 5, 1906.

mercury connected metallically to the earth; and the wire on the inside of the tube was connected to a quadrant electrometer. Under these conditions, positive electricity was discharged from the wire, for five or six minutes, and the electrometer indicated the accumulation of a negative charge. After the expiration of ten minutes, the electrometer indicated the accumulation of a positive charge, and the emission from the wire of negative electricity. This is in accord with the accepted views as to the charges carried by the α and β rays. Radium A radiates α rays only, and radium C, both α and β rays. Further, radium A disappears in ten minutes, so that the α rays, coming from radium A and radium C, passing through the rubber, caused a negative charge to appear on the wire for the first few minutes. After ten minutes radium A disappeared, and the positive charge appearing at that time was due to the β rays of radium C, the β rays passing through the rubber more easily than the α rays.

In the second series of experiments, a wire was made radioactive as before, and placed inside of and coaxial with a metal tube, the diameter of which was very slightly greater than that of the wire. The metal tube was made air-tight, and the air within it rapidly exhausted to a pressure of about one tenth of a millimeter of mercury. The wire being connected to the electrometer, and the tube to earth, the deflections of the electrometer indicated a continual accumulation of a positive charge from the very start. A series of careful measurements were made of the rate of discharge of negative electricity from the wire at different instants of time after the wire had been taken out of the emanation. These measurements showed plainly that the rate of discharge of negative electricity was not proportional to the ordinary ionization effect of the induced activity; that is, was not proportional to the quantity of radium A and C present on the wire. The curves, representing the decay of the rate of emission of electricity, are much steeper than those representing the rate of decay of the ionization currents, except for the first ten minutes. They agree, approximately, with the theoretical curves, given by Rutherford, representing the sum of the quantities of radium B and radium C on the wire. From this we may conclude that radium B, which hitherto has been considered non-radioactive, emits, approximately, as much negative electricity as does radium C.

If the tube and wire are placed in a magnetic field, so that the lines of force of the field are parallel to the axis of the tube, the rate of emission of electricity is considerably decreased. Further, an electromotive force of a few volts will stop a portion of the discharge of electricity. From these two experiments, it appears, using the usual formulas, that the ratio of the charge to the mass of the carriers of this negative electricity is, at least roughly, equal to that of the β rays. The experiments, however, give only the order of magnitude of this ratio. The velocity, too, of the carriers is very much smaller than that of the β rays, which explains the fact that the rays do not pass through the thin rubber tube, and do not produce a sufficient ionizing effect, to have been discovered by the ionization of gases. The small velocity indicates that the carriers are probably similar to those called by J. J. Thomson δ rays.

A much more detailed account of the experiments will be published as soon as the absolute quantity of electricity emitted by a given quantity of induced activity has been measured.

WILLIAM DUANE.

THE USE OF ASTRONOMICAL TELESCOPES IN DETERMINING THE SPEEDS OF MIGRATING BIRDS.

DURING the spring and fall of 1905 there was developed at the University of Illinois Observatory a method of determining the heights of migrating birds. Two observers watched the moon's disk at night through small telescopes placed some distance apart, and from the different paths seen projected against the moon from the two stations, it was possible to compute the height and direction of flight for each bird. These methods and results are given in papers by Messrs.

Stebbins[1] and Carpenter.[2] It was found that the migrating birds flew much lower than has hitherto been supposed, most of them being less than 1,500 feet from the ground at the time of observation.

The writers of the present article have recently used the same instruments for the purpose of measuring the speeds of migrating birds. The theory of the method is simple enough. Observer F. with a three-inch telescope, was stationed 200 feet south of S., who used a four-inch instrument. On seeing a bird, F. would call 'time' when it left the disk, and S. estimated the interval in seconds until the bird had passed off the moon's edge from his point of view. By drawing a figure it may easily be seen that in the observed interval, the bird had crossed a space not less than the distance between the stations. The lines joining the two observers with the moon were parallel and 200 feet apart, measured horizontally from south to north. From the time required to pass 200 feet, the speed of the bird in miles per hour was derived.

We were successful with this method on only one night during the last migrating season, May 18, 1906. F. at the south station called 'time' for ten different birds, of which three were seen by S. At the signal 'time,' S. would count seconds to himself: 'and, one, and, two, and,' etc., the first 'and' being a half second after 'time,' another half second interval to 'one' and so on. Both of us have had some years' experience in observing transits of stars by the 'eye and ear method,' and we believe these results more accurate than could be obtained with a stop watch.

Two birds crossed the space of 200 feet in one second, and the third in a second and a quarter. The data and results may be summed up in the following table where a correction of 0.2 second has been added to the observed interval to allow for the velocity of sound.

MAY 11, 1906. WIND S.W., 14 MILES PER HOUR.

Bird	1	2	3
Time of observation	11.30	11.38	11.50
Time to travel 200 ft. (in sec.)	1.0	1.25	1.0
Corrected time	1.2	1.45	1.2
Speed in miles per hour	114	94	114

It should be remembered that these are minimum speeds, for if the birds were not traveling due north they passed over more than 200 feet between observations. From the directions of their projected paths we would conclude that they were actually flying northeast, but we devoted nearly all of our attention to the estimate of times. We consider these results to be correct within ten or fifteen per cent., and, therefore, place the observed minimum speeds between 80 and 130 miles per hour. To obtain the actual motion through the air, these quantities should perhaps be reduced by fourteen miles per hour, the velocity of the wind as shown by an anemometer. The birds were flying nearly with the wind.

To one who has not tried this method, the question at once presents itself: How was it known that both observers saw the same bird? When one has kept his eye fixed at the end of a telescope for five or ten minutes seeing nothing but the moon, and a bird appears within a second after his companion calls 'time,' there is no doubt in his mind that one and the same bird was seen. Moreover, it is possible to show that the path seen by the second observer was in prolongation of that recorded by the first.

It is unfortunate that we did not secure more observations. The observers interchanged places and watched for another half hour, but no more birds were seen from both stations. In all F. saw about thirty-five birds and S. fifteen during the period $11^h\,20^m$ to $12^h\,20^m$ on the above night. We tried on the two succeeding nights, but there were passing clouds, and apparently fewer birds were flying.

So far as we know this is the first time that two telescopes have been used to determine the speed of birds at night. Professor F. W. Very,[3] working at the Ladd Observatory,

[1] Stebbins, Joel, 'A Method of Determining the Heights of Migrating Birds,' *Popular Astronomy*, **14**, 65, February, 1906.

[2] Carpenter, F. W., 'An Astronomical Determination of the Heights of Birds during Nocturnal Migration,' *The Auk*, **23**, 2, April, 1906.

[3] Very, F. W., 'Observations of the Passage of Migrating Birds across the Lunar Disk on the

Providence, R. I., deduced from the time required to pass across the moon's disk, a speed of about 130 miles per hour for some birds. Our results agree closely with his, although the methods are very different. He had to assume the size of the birds in order to compute their distances and speeds, while with two telescopes the results are independent of any assumption as to size or distance. On the other hand, it is possible to secure many more observations with a single instrument than with two, so there are disadvantages in both methods.

With three telescopes it would be possible to measure both the heights and speeds of birds as they fly across the moon. Two observers about ten feet apart in an east-and-west line could obtain data for the heights, while the speeds could be determined by a third observer situated a hundred yards north or south of the others. In short, given a clear night, the moon about full, plenty of birds in flight, and a battery of telescopes, the conditions are perfect for an easy solution of the problem of the heights and speeds of migrating birds; but it will be seldom that all of these requirements are fulfilled at the same time.

JOEL STEBBINS,
EDWARD A. FATH.
UNIVERSITY OF ILLINOIS OBSERVATORY,
May, 1906.

of a twenty-six-inch bed of workable coal, and five thousand for a thirty-six-inch bed, it is only within the past few days that any one has filed with the governor legitimate claims for the bounty. The bed of coal recently exposed, near Peru, Neb., extending some forty-two feet along the sides of a tunnel back from the banks of Honey Creek, seems to be fully thirty-four inches in thickness, as measured by the writer. This is known as the Honey Creek or Peru coal mine. The seam is level and readily accessible; the mine, being ten feet above the creek, is easily drained and transportation is at hand. While the extent of the newly discovered bed is a matter of conjecture, the farms near and adjacent to the Peru coal bed are likewise underlaid probably with the same seam of coal, judging from scattered surface indications. It is reasonably certain that a resource of local interest will be developed, and for a time at least Nebraska may lose its distinction 'the state without a mine.' As to the quality of the coal, whether good or bad, matters little, for any coal is good in a state supposed to be destitute of natural fuel. Analyses of the Honey Creek coal made by Mr. L. J. Pepperberg, a fellow in the department of geology in the University of Nebraska are given in the table.

It must be remembered that the following analyses are made from samples which are close to the surface, badly weathered, therefore representing the worst rather than the best of this coal.

By the time the tunnel has been extended one hundred feet the overlying shales will be about fifty feet in thickness and the coal will presumably be of better quality. Across the

	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Total.	B. T. U. per Pound of Coal.	Volatile Matter Per Cent. of Combustible.	Fixed Carbon Per Cent. of Combustible.
Sample No. I., air-dried	10	45.25	36.28	8.47	100	12,621	55.50	44.50
Sample No. II., water-soaked as mined	32.22	28.54	19.38	19.86	100	7,492	54.80	45.20
Sample No. III., lignitic coal, Cumberland, Wyo., for comparison	3.65	44.27	46.18	5.90	100	14,100	54.90	45.10

A WORKABLE BED OF COAL IN NEBRASKA.

ALTHOUGH for years past the state legislature of Nebraska has offered a bounty amounting to four thousand dollars for the discovery

Nights of September 23 and 24, 1896,' SCIENCE, N. S., 6, 409, September 10, 1897.

valley of the Missouri in Iowa a bed of coal, similar in all respects to this one, occurs, and is probably a part of the same bed. The evidence from deep wells at Omaha, Nebraska City, Beatrice and Lincoln, the last named well being 2,463 feet deep, points to beds of coal but a few inches in thickness and thinning rapidly to the westward.

For a number of years coal has been mined in various places in the southeastern, or carboniferous portion of this state, as at Nebraska City, Rulo, South Fork and elsewhere, but the thickness of coal in each case scarcely equaled eighteen inches and there was no profit in mining such coal. The best efforts of a Lincoln company headed by Mr. Bullock, a man of ability and experience, failed to make the mine at Rulo profitable, and the undertaking, like that of others, was abandoned at the end of two years as unprofitable.

Although considerable amounts of coal were furnished at one time by the South Fork Mine to the neighboring towns, Table Rock, Humboldt, Salem, Dawson and Seneca, the bulk of coal mined thus far has been used by those mining it. Farmers and others often dig out their own supply of winter fuel. A vigorous effort was made to develop a bed, said to be eighteen inches thick, in northeastern Nebraska, it being a lignitic coal in the Cretaceous and in no way related to the coal recently discovered. Simultaneously with the discovery of coal at Peru come reports not yet verified of a bed equally thick at Falls City. It has certainly been the opinion of geologists at large that commercial coal was not to be expected in Nebraska, and the occurrence of a workable bed in Peru does not materially change this opinion, for at the best it must be local, as shown by surrounding deep wells. Though limited to a square mile or so it is of importance to this commonwealth.

The owner of the land on which the bed of coal was found leased the mine at the rate of fifty cents on every ton of coal sold for three dollars, and one dollar on every ton sold at four dollars, which may be an item of interest to those regularly engaged in mining.

Erwin H. Barbour.
The University of Nebraska, Lincoln,
April 5, 1906.

THE RELATION OF PRESSURE IN THE CORONARY VESSELS TO THE ACTIVITY OF THE ISOLATED HEART, AND SOME CLOSELY RELATED PROBLEMS.[1]

The data recorded in this note were obtained in a series of experiments on the excised hearts of turtles, and on the hearts of guinea-pigs, rabbits, cats and dogs, both excised and in situ. The object was to study the effect of various artificial nutrient solutions under different conditions of temperature and pressure with a view of determining their efficiency in restoring cardiac activity. By efficiency is meant the capability of the heart of maintaining an adequate blood pressure.

Defibrinated blood, blood dilutions, Locke's, Ringer's, Howell and Greene's two solutions, 0.9 per cent. sodium chloride, paraffin oil and hydrogen gas were employed.

The animals were etherized and rapidly bled to death, and the blood collected and defibrinated. In isolated preparations, the hearts were rapidly removed and suspended by the base. Cannulæ were inserted and the pericardium removed. Ventricular tracings were made by connecting this portion of the heart to a simple lever which recorded the contractions on a drum. Auricular tracings also were made in some experiments. In all cases of isolated preparations, before the injection was begun, the hearts were bathed in the solutions to be employed. With all the solutions except blood, or blood dilutions, oil and hydrogen, a short series of more or less rhythmical contractions, similar to those evoked by simple mechanical stimulation, promptly followed their application to the heart. In the course of the experiments with the hearts in situ, a constant parallelism was observed between the aortic pressure and the rate of the heart. In order to determine whether this result was

[1] All references to literature have been purposely omitted.

due to intraventricular or to coronary pressure, the heart was excised and the ventricles slit open; injections under pressures varying from 44 mm. to 200 mm. of mercury were then made through the aorta and also directly into the anterior coronary artery. On cessation of the contractions following the external application of the solution to the heart, perfusion through the coronary arteries was begun, and with blood and its mixtures, oil, hydrogen gas, and all solutions, rhythmical beats followed, the magnitude and rate of which varied with the pressure. The evidence seems conclusive that there exists for each solution a certain optimum pressure which produces the maximum rate without a diminution of the amplitude, and that this optimum changes with the condition of the heart. With hearts from the same species of animals, the optimum pressure for each solution may vary widely at corresponding periods of the experiment. The actual change in rate for a given change in pressure may not be constant for different hearts under similar conditions; nor for the same heart under different conditions. The rate may change three hundred per cent. within the limits of the pressure used, variations occurring when the pressure is changed (1) from low to high, or (2) from high to low. Increase in pressure may be considered as a stimulation in the ordinary sense of the term, for the reason that an increase above the optimum causes an increase in rate, and that delirium cordis may be produced if the pressure be raised sufficiently high. If the pressure now be gradually lowered a regular rhythm returns, which becomes slower concomittantly with the fall in pressure. With the same heart, several successive increases and decreases of pressure may cause nearly identical rhythms at corresponding pressures, the gradual increase or decrease of pressure being attended by a fairly constant change in rate for corresponding changes in pressure. A sudden and profound fall in pressure may cause either (1) an immediate increase in rate succeeded by a decrease to the rate previously observed for that pressure, or (2) a slowing of the rate, even to total cessation, succeeded by a return to the rate previously observed for that pressure. The first phenomenon bears some resemblance to that following a sudden fall of blood pressure in the intact animal, *i. e.*, acceleration, and the second bears a striking resemblance to vagus inhibition in the intact heart. In the preliminary experiments with the heart in situ the higher cardiac nerve centers were inactive. When the animal is under light anæsthesia, the changes in rate produced by changing the pressure, both before and after section of the cardiac nerves, are not the same as in the isolated heart, or in the resuscitated heart in situ. The changes in the rhythm are not due to alterations in intraventricular pressure. If, in the turtle, the cannula is introduced directly into the ventricle the beat may be practically stopped, owing, presumably, to distention of the ventricle. Free incision of the ventricles in the excised mammalian heart precluded any distention.

With hearts in situ, and in good condition, following injection of blood dilutions into the aorta, the left ventricle got up a pressure greater than that used for injecting. In no instance were efficient contractions obtained by injecting artificial solutions alone. Their use appears to cause a rapid deterioration of cardiac tissue as regards its susceptibility to restoration and efficiency, though complete loss of irritability may not occur for a long time; *e. g.*, from strips of cats' ventricles bathed in Locke's solution, tracings were taken showing contractions for a period of more than six hours, at which time the experiment was discontinued. Efficient contractions, maintained for relatively long periods, followed the injection of defibrinated blood or blood dilutions. If the perfusion with artificial solutions had not been too prolonged, the hearts could be restored to fairly good condition by perfusion with blood mixtures. The optimum pressure for blood and its dilutions was considerably higher than that for the artificial solutions. This difference may be due in part to a difference in viscosity, but it is also possible that artificial solutions increase the excitability of the preparation by direct action primarily on the vessel walls. Two facts lend some support to this view: (1) bathing

the hearts with artificial solutions is attended by contractions, while blood and its mixtures produce no such effect; and (2) if two strips of cat's ventricle, one cut so as to include a considerable part of the anterior coronary artery, and the other cut from the anterior lateral margin of the right ventricle so as to include no large vessels, be suspended and irrigated with the artificial solutions, the strip containing the coronary artery soon exhibits strong tonus upon which contractions may be superposed, while a little later the other strip begins to contract more or less irregularly and without any change in tonus. It may be observed in this connection that a strip of thoracic aorta may exhibit a deportment similar to that of the ventricular strip containing the coronary artery.

From these observations we conclude that, with hearts under the conditions of our experiments: (1) It is highly improbable that the production of a rhythmical beat is dependent solely upon the constituents of any one of the artificial solutions employed; that these solutions alone are not sufficient to initiate or sustain efficient beats of the heart. It has been shown in this and other laboratories that such solutions are inadequate to restore or even to sustain the activities of the reflex nervous centers of mammals. We have found the addition of a certain amount of blood necessary to render these solutions efficient. (2) For the production of the efficient rhythmical beat of the isolated heart, pressure or circulation of a suitable medium in the coronary vessels is necessary. Injection of blood or its dilutions into the coronary veins is attended by much the same phenomena as have been recorded for injections into the coronary artery, the principal differences being the somewhat lower optimum pressure and the lower pressure necessary for the production of delirium cordis. The character of the beat may differ somewhat in the two cases. As the pressure in the veins necessary to produce rhythmical beats is in all probability higher than that normally present, the mechanism which initiates the normal rhythmical beat must be sought elsewhere. In further support of this view may be mentioned the fact, as determined by inspection, that, on injecting into the coronary artery, the beat begins before much blood appears in the coronary vein, although the beats are weak before the complete establishment of the coronary circulation. In suitable preparations, in which the rhythm is slow, the coronary artery, or the tissue immediately surrounding it, has been observed to pulsate, and the beat to spread from the coronary vessels over the heart.

C. C. Guthrie,
F. H. Pike.

Hull Physiological Laboratory,
The University of Chicago,
May 25, 1906.

NOTES ON ORGANIC CHEMISTRY.

ESTERIFICATION OF TERTIARY AND UNSATURATED ALCOHOLS.

Not long ago there was given, in this journal, an account of some recent improvements in the methods of preparing esters.[1] Although these are of undoubted value, yet the subject, as a whole, can not be said to be in a very satisfactory state because there are no methods, of general applicability, capable of furnishing a good yield of the esters of tertiary and unsaturated alcohols. The primary cause of the difficulty is the greater sensitiveness of these classes of alcohols, which results in the production from them of other compounds, such as unsaturated hydrocarbons or tarry products, in relatively large quantity. This behavior is further accentuated by the fact that the velocity of their reaction and their equilibrium points are both very low. Whereas, in the case of propyl alcohol, if 46.5 per cent. is esterified in one hour and 66.8 per cent. is esterified before equilibrium is attained, these values become 26.5 and 60.5 per cent., respectively, for secondary propyl alcohol, and for *tertiary*butyl alcohol, 1.5 and 6.6 per cent. The figures speak for themselves and demonstrate how great, relatively, is the opportunity for change to take place in the tertiary alcohol by the action of the high temperature or of the mineral acid or other 'catalyst' that may be present.

[1] Science, XXIII., 712 (1906).

The Grignard reaction, since its discovery a few years ago, has been extremely productive of valuable results and appears to be capable of rendering service in this case also. An ingenious application of it, described recently by J. Houben,[2] constitutes an important advance towards the solution of the general problem described above. The process consists of the following stages: Magnesium, an alkyl haloid and absolute ether are allowed to react in the ordinary manner, to give the Grignard reagent; if ethyl chloride is employed the action may be represented by the equation: $Mg + C_2H_5Cl \rightarrow MgClC_2H_5$. The ethylmagnesium chloride is mixed with the alcohol to be experimented with and there results a hydrocarbon and magnesium alkyloxy chloride; with *tertiary*butyl alcohol the reaction would be: $C_2H_5MgCl + (CH_3)_3COH \rightarrow (CH_3)_3COMgCl + C_2H_6$. The ethane, of course, escapes. The last step consists in adding acetic anhydride to the above product, which results in the formation of *tertiary*-butyl acetate and magnesium acetochloride:

$$(CH_3)_3COMg + (CH_3CO)_2O \rightarrow (CH_3)_3COCOCH_3 + CH_3COOMgCl.$$

The preceding method has already led to the synthesis of a variety of acetates of geraniol and of terpin series, such as terpin diacetate; the resulting compounds are closely allied with some of the odoriferous materials of plants, and their further study promises results of importance and value. The method also gives good service in the esterification of phenols.

Benzylmagnesium chloride, $C_6H_5CH_2MgCl$, may be used in place of the ethyl derivative, but curiously enough, the corresponding bromides or iodides can not be employed; with the former the yield is poor and with the latter the reaction is practically inhibited, except in the case of saturated alcohols, for which, however, the bromides are preferable. The results of a more extended investigation of this subject will be awaited with interest.

J. BISHOP TINGLE.

JOHNS HOPKINS UNIVERSITY.

[2] *Ber. d. Chem. Ges.*, **39**, 1736 (1906).

RECENT VERTEBRATE PALEONTOLOGY.

Extinct Mammals of Patagonia.—The third part of the first volume of the *Annales de Paléontologie* under the direction of Dr. Marcellin Boule, professor of paleontology in the Museum of Natural History of Paris, has just been received. It contains the conclusion of Professor Albert Gaudry's review of the fossils of Patagonia, in which this distinguished paleontologist presents the most clear and interesting account of the mammalian life, especially in the Eocene, Oligocene and Lower Miocene. Summaries of the geological results obtained by Hatcher, Ortmann, Tournouer, are given, together with a discussion of the environment of the remarkable succession of mammalian life. This is by far the clearest and most interesting presentation we have yet had of the development of this peculiar fauna. The author is a strong believer in the existence of an Antarctic continent; in fact he regards this fauna as the fauna of such a continent. He observes that Patagonia serves to give us a clear idea of its geographical extent by its climate, remarking 'that if Patagonia is not a part of an Antarctic continent its paleontological history is altogether incomprehensible.' It is interesting to contrast this statement with one recently made to the writer by Sir John Murray to the effect that he found no evidence whatever sufficient to convince him even of the existence of such a continent.

Eocene Mammalia of Northern Africa.—By far the most important paleontological event of recent times was the discovery in 1900 of the ancient fauna of the Fayûm. This is the lake province of Egypt, a district occupying a depression in the desert to the west of the Nile Valley opposite Wasta, a small town about fifty-seven miles south of Cairo. From time to time since this discovery Messrs. Beadnell, of the Egyptian Geological Survey; Dames, of Berlin; Stromer, of Munich; Fraas, of Stuttgart, and especially Andrews, of the British Museum of Natural History, have been presenting short contributions to our knowledge of this fauna. We have now received 'A Descriptive Catalogue

of the Tertiary Vertebrata of the Fayûm, Egypt, based on the collection of the Egyptian government in the Geological Museum, Cairo, and on the collection in the British Museum (Natural History), London,' by Charles William Andrews. The volume is a fine quarto of 324 pages, with twenty-six plates, and a large number of text figures, including several restorations. It is no exaggeration to say that it marks a turning point in the history of the mammalia of the world.

First and foremost is the fact that the ancestors of three great orders of mammals, namely, the Hyracoidea, Sirenia and Proboscidea, are definitely carried back to the Upper Eocene, and the birthplace of these orders appears to be firmly established on the great continent of Africa, which was especially distinguished through a very long geological period as a land mass much less affected by submergence than the other continents, and, therefore, a peculiarly favorable theater for the evolution of terrestrial mammals.

Second, the problematical order of Zeuglodontia, aberrant whale-like forms, are definitely carried back to the Middle Eocene and apparently connected firmly with the land-living primitive Carnivores known as Creodonts. This demonstration we owe to a discovery by Professor Eberhard Fraas, of Stuttgart, a fact which is fully set forth in the present work.

Third, we have established here the occurrence of two entirely distinct and extremely aberrant forms of mammals, both of which possibly represent new and distinct orders, namely, *Arsinöitherium* and *Barytherium*. *Arsinöitherium* is now fully known and differs from every other mammal both in its dentition and in the anatomy of the skull, a most remarkable feature of which is a very large and forwardly pointed pair of horns. The limbs are analogous to those of the Proboscidea and Dinocerata.

Fourth, mingled with these aberrant and peculiarly African forms in the Upper Eocene are the only carnivorous types thus far found, namely, the primitive Creodonta, resembling those of France and North America, and suggesting a land connection and mammalian invasion from Europe. Certain of the Artiodactyl Ungulates characteristic of the Upper Eocene of Europe also appear here, namely, the Anthracotheres.

We may, therefore, consider the hypothesis which was advanced more or less fully and independently in 1900 by Osborn, Stehlin and Tullberg, that Africa was a very important center in the evolution of mammalian life firmly established as a fact; further, that Africa contributed the Hyracoidea, the Sirenia and the Proboscidea to the continents of Europe, Asia and in part to North America.

Some confirmation is also found for the hypothesis which dates back to De Blainville, namely, that widely separated as the Sirenia and Proboscidea are to-day, they may have had a community of origin in Lower Eocene times.

Dr. Andrews is also inclined to regard the evidence which he has now brought together as lending additional support to the theory that in late Mesozoic times Africa and South America were still connected by land. He concludes: 'It appears certain that the final separation of the two continents did not take place till Eocene times,' and that there may have been a chain of islands between the northern part of Africa and Brazil which persisted even till the Miocene. This rests on much more slender evidence than the well-established land connection between Patagonia and Australia, but the résumé which the author gives of the anomalies of distribution which would be explained by such a connection is well worth quoting in full (pp. xxvi–xxvii):

> On the assumption that this series of events did happen, there is little difficulty in accounting for most of the peculiarities in the distribution of the various groups. Thus, to mention only a few instances, the presence in both continents of the Hystricomorphine rodents, of chelonians of the family Pelomedusidæ, and of the fishes of the family Cichlidæ is at once accounted for. So also is the presence in the Santa Cruz beds of *Necrolestes*, apparently a close ally of the Cape Golden moles, and of the Sparassodonta, which,

after all, seem to be creodonts and not marsupials. Furthermore, light is also thrown on the numerous points of similarity between Struthiones and the Rheæ, especially when it is remembered that a large ratite bird, *Eremopezus*, existed in the Eocene of Africa. As to the ungulates, it seems likely that the separation of the two areas took place when the main divisions were only just beginning to be differentiated, and that groups like the Pyrotheria and the Archæohyracidæ are not ancestral to the Proboscidea and Hyracoidea of the old world, but more probably represent terms of partly parallel series which had a common ancestry on the common land-surface before the separation of the two regions took place. If this were so, we should expect to meet with a general resemblance between the various groups rather than a close similarity of structure, and this, in fact, is what we find. In the case of the occurrence of the primitive sirenian *Prorastomus* in the West Indies, and of the water-snake *Pterosphenus* in the Eocene beds of Alabama, it seems likely that these animals passed either along the southern coast of the Eocene Atlantic or across the bridge of shallow water between the chain of islands above referred to as probably lying between West Africa and Brazil.

The work is admirably printed and illustrated, and includes reference to all of the literature; and the author as well as the directors and trustees of the British Museum are greatly to be congratulated.

HENRY F. OSBORN.

THE INTERNATIONAL FISHERY CONGRESS, 1908.

AT the Paris universal exposition of 1900 there was held an international congress of fisheries and pisciculture, a permanent committee on international fishery congresses was formed, and plans were laid for holding such congresses regularly in various countries. The first congress was under the presidency of Professor Edmond Perrier, director of the National Museum of Natural History in Paris. The second congress met in St. Petersburg in 1902, under the presidency of Hon. Vladimir Weschniakow, secretary of state and president of the Russian Imperial Fishery Society. The last congress convened at Vienna in 1905 and was presided over by Professor Dr. Franz Steindachner, director of the Imperial Museum of Natural History in Vienna. I attended that congress as the representative of the United States, and extended an official invitation to hold the next meeting in America in 1908, the invitation being unanimously accepted. The place of meeting is Washington, D. C., and the time is September 22 to 26 inclusive. It is a source of gratification to announce that the president of the next congress is Dr. Hermon C. Bumpus, director of the American Museum of Natural History.

In connection with the congress there have been arranged a number of competitive awards for the best or most important investigations, discoveries, inventions, etc., relative to fisheries, aquiculture, ichthyology, fish pathology and related subjects during the years 1906, 1907 and 1908. The awards will be in the form of money; and, although the individual amounts are not large, it is hoped that the conferring of the awards by so representative a body will induce many persons to compete and will result in much benefit to the fisheries and fish culture. The following awards have thus far been provided, and others may be announced later:

By the American Fisheries Society: For a paper embodying the most important original observations and investigations regarding the cause, treatment and prevention of a disease affecting a species of fish under cultivation. $100.

By the American Museum of Natural History: For an original paper describing and illustrating by specimens the best method of preparing fish for museum and exhibition purposes. $100.

By Forest and Stream: For the best paper giving description, history and methods of administration of a water, or waters, stocked and preserved as a commercial enterprise, in which angling is open to the public on payment of a fee. $50.

By the Museum of the Brooklyn Institute of Arts and Sciences: For the best paper setting forth a plan for an educational exhibit of fishes, the species and specimens that should be shown, the method of arrangement, and suggestions for making such an exhibit instructive and attractive. $100.

By the New York Aquarium: For an exposition of the best methods of combating fungus disease in fishes in captivity. $150.

By the New York Botanical Garden: For the best essay on any interrelation between marine plants and animals. $100.

By the Smithsonian Institution: For the best essay or treatise on 'International regulations of the fisheries on the high seas, their history, objects and results.' $200.

By the Fisheries Company, New York City: For the best essay treating of the effects of fishing on the abundance and movements of surface-schooling fishes, particularly the menhaden and similar species, and the influence of such fishing on the fishes which may prey on such species. $250.

By the United States Bureau of Fisheries: For a report describing the most useful new and original principle, method or apparatus to be employed in fish culture or in transporting live fishes (competition not open to employees of the bureau). $200.

By the Wolverine Fish Company, Detroit, Michigan: For the best plan to promote the whitefish production of the Great Lakes. $100.

By Mr. Hayes Bigelow, Brattleboro, Vermont, member of the American Fisheries Society: For the best demonstration, based on original investigations and experiments, of the commercial possibilities of growing sponges from eggs or cuttings. $100.

By Hon. George M. Bowers, United States Commissioner of Fisheries: For the best demonstration of the efficacy of artificial propagation as applied to marine fishes. $100.

By Dr. H. C. Bumpus: For an original and practical method of lobster culture. $100.

By Mr. John K. Cheney, Tarpon Springs, Florida, member of the American Fisheries Society: For the best presentation treating of the methods of the world's sponge fisheries, the influence of such methods on the supply of sponges, and the most effective means of conserving the sponge grounds. $100.

By Professor Theodore Gill, Smithsonian Institution: For the best methods of observing the habits and recording the life histories of fishes, with an illustrative example. $100.

By Dr. F. M. Johnson, Boston, Mass., member of the American Fisheries Society: For the best demonstration of the comparative value of different kinds of foods for use in rearing young salmonoids, taking into consideration cheapness, availability and potentiality. $150.

By the New York Academy of Sciences: For that contribution presented at the congress and not provided for in the foregoing awards which is adjudged to be of the greatest practical importance to the fisheries or to fish-culture. $100.

Further information concerning this matter will be furnished on application to the undersigned general secretary.

H. M. Smith.

U. S. Bureau of Fisheries,
Washington, D. C.

THE PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON.

Of the *Proceedings* of the Royal Society of London, as divided about a year ago into two series, Vols. 76–77 of series 'A,' containing papers of a mathematical and physical character, and Vols. 76–77 of series 'B,' containing papers of a biological character, have now appeared, each running to about 600 pages royal octavo, with illustrations. A main object of this new arrangement was to render the proceedings more accessible to workers by placing the two groups of subjects on sale separately, at a stated price attached to each separate part of a volume when it first appears. Moreover, with a view to promoting the circulation of the complete series, it has been directed that a subscription paid in advance to the publishers at the reduced price of 15s. per volume for either series, shall entitle subscribers to receive the parts as soon as published, or else the volumes when completed, in boards or in paper covers, as they may prefer.

With a view to further increasing the accessibility of the various publications of the Royal Society, each number of proceedings now contains an announcement on the cover, of the more recent memoirs of the Philosophical Transactions as published separately in wrappers and the prices at which they can be obtained.

It is hoped that by this arrangement the difficulties which have been found to impede the prompt circulation of the journals of the society, which are of necessity published in a somewhat different manner from a regular periodical, may be finally removed.

THE AGRICULTURAL APPROPRIATION BILL.

The agricultural appropriation bill for the fiscal year ending June 30, 1907, as finally

passed by the recent session of congress carries an appropriation of $9,932,940. Of this amount the sums appropriated for what may be termed work in applied science are distributed as follows:

The Bureau of Animal Industry receives $4,029,460, but of this amount $3,000,000 are to be devoted to the meat inspection, the discussion of which has occupied so much of the time of congress and of the public press during the past few weeks; Weather Bureau, $1,439,240; Bureau of Plant Industry, $1,024,740; Forest Service, $1,017,500; Agricultural Experiment Stations, including the Department Office of Experiment Stations, $974,860; Bureau of Entomology, $262,100; Division of Publications, $248,520; Bureau of Soils, $221,460; Bureau of Statistics, $210,560; Bureau of Chemistry, $174,180; Office of Public Roads, $70,000; Bureau of Biological Survey, $52,000; Library, $25,880.

The growth of this great government department has been marvelous during the past decade, and the value of its administration to the country at large seems, by results, to have justified this increase in its appropriations.

CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING.

THE following list of forty-six institutions is announced by the executive committee of the Carnegie Foundation for the Advancement of Teaching as a first provisional list of colleges and universities admitted to the benefits of the Carnegie Foundation for the Advancement of Teaching.

To professors in these institutions the privileges of the retiring allowances are extended, under the rules of the foundation, as a regular part of the academic compensation and through their own institutions. That is to say, the professors in these institutions receive the allowances which their services earn, immediately upon the request of their institution, as a matter of right.

From this list are omitted all institutions having formal denominational connections, or which require their trustees or officers to belong to a specified denomination. A number of these institutions may in time make clear to the trustees their right to a place in the list.

Similarly are omitted all institutions controlled and supported by a state, province or municipality. The question of the admission of such institutions to the benefits of the Carnegie Foundation will be decided at a meeting of the trustees in November, at which time the representatives of state institutions will have a full opportunity to present any statement they may desire.

All institutions are omitted from this list which fall below the academic standard of a college which the trustees have adopted. Many of these will in time be able to claim places in the list of accepted institutions by raising their standards of entrance or of work. To all three of these classes of institutions there can be no hardship in such delay as may be necessary to enable the trustees to deal thoroughly and fairly with the questions of educational standard and of denominational and state control.

It is not to be understood that the institutions named below are the only ones in which teachers will be granted retiring allowances even at the present time, but to professors in institutions not on the accepted list retiring allowances thus voted will be individual grants in recognition of unusual or distinguished service as a teacher. The trustees have sought to recognize in a generous way individual scholars and the list of those to whom retiring allowances have already been voted includes a number of the most eminent names among American teachers.

The Carnegie Foundation does not give out an official list of those to whom retiring allowances have been granted, but among those whose names have been published in the daily papers are the following: Henry Pickering Bowditch, professor of physiology at Harvard University; George Trumbull Ladd, professor of philosophy at Yale University; Francis A. March, professor of English and comparative philology at Lafayette College; Edward W. Morley, professor of chemistry at Western Reserve University; John Krom Rees, professor of astronomy at Columbia University; Charles Augustus Young, professor of astronomy at Princeton University.

INSTITUTIONS IN THE UNITED STATES.

Amherst College, Amherst, Mass.
Beloit College, Beloit, Wisconsin.
Carleton College, Northfield, Minn.
Case School of Applied Science, Cleveland, Ohio.
Clark University, Worcester, Mass.
Clarkson School of Technology, Potsdam, N. Y.
Colorado College, Colorado Springs, Colo.
Columbia University, New York City.
Cornell University, Ithaca, N. Y.
Dartmouth College, Hanover, N. H.
George Washington Univ., Washington, D. C.
Hamilton College, Clinton, N. Y.
Harvard University, Cambridge, Mass.
Hobart College, Geneva, N. Y.
Johns Hopkins University, Baltimore, Md.
Knox College, Galesburg, Ill.
Iowa College, Grinnell, Iowa.
Lawrence University, Appleton, Wis.
Lehigh University, S. Bethlehem, Pa.
Leland Stanford Univ., Stanford Univ., Cal.
Marietta College, Marietta, Ohio.
Mass. Inst. Tech., Boston, Mass.
Middlebury College, Middlebury, Vt.
Mt. Holyoke College, S. Hadley, Mass.
New York University, New York City.
Oberlin College, Oberlin, Ohio.
Polytechnic Institute, Brooklyn, N. Y.
Princeton University, Princeton, N. J.
Radcliffe College, Cambridge, Mass.
Ripon College, Ripon, Wisconsin.
Smith College, Northampton, Mass.
Stevens Institute Technology,[1] Hoboken, N. J.
Trinity College, Hartford, Conn.
Tulane University,[1] New Orleans, La.
Union College, Schenectady, N. Y.
University of Pennsylvania, Philadelphia, Pa.
University of Vermont, Burlington, Vt.
Vassar College, Poughkeepsie, N. Y.
Wabash College, Crawfordsville, Ind.
Washington University, St. Louis, Mo.
Wellesley College, Wellesley, Mass.
Wells College, Aurora, N. Y.
Western Reserve University, Cleveland, Ohio.
Williams College, Williamstown, Mass.
Western Univ. of Penn., Pittsburg, Pa.
Yale University, New Haven, Conn.

INSTITUTIONS IN CANADA.

Dalhousie University, Halifax, N. S.
McGill University, Montreal, Canada.

[1] On the basis of entrance requirements of 1907.

SCIENTIFIC NOTES AND NEWS.

Dr. Ernst Mach, of Vienna, has been awarded the Bavarian Maximilian order for science and art.

Oxford University conferred, on June 20, the honorary degree of doctor of science on Dr. John Milne, F.R.S., known for his researches in seismology.

The Technical Institute of Berlin has conferred on Mr. George Westinghouse the degree of doctor of engineering.

The University of Vermont has conferred the degree of doctor of science on Mr. C. G. Pringle, keeper of the herbarium of the university.

Dr. William W. Keen, professor of surgery in the Jefferson Medical College, Philadelphia, has been elected a trustee of Vassar College to fill the vacancy caused by the death of Dr. Edward Lathrop.

M. Charles Trépied, director of the Astronomical Observatory of Algiers, has been elected a corresponding member of the Paris Academy of Sciences.

Dr. E. Ludwig, professor of medical chemistry in the University of Vienna, has been elected an active member, and Dr. J. Herzig, professor of chemistry, a corresponding member, of the Vienna Academy of Sciences.

Dr. Cannizzaro, professor of chemistry at Rome, and director Dr. H. Th. Böttinger, of Elberfeld, have been elected honorary members of the German Bunsen Society.

Dr. G. Kraatz, the Berlin entomologist, has celebrated the fiftieth anniversary of his doctorate.

Dr. T. P. Anderson Stuart has been elected president of the Royal Society of New South Wales.

The international celebration of the Coal-Tar Color Jubilee will be held on July 26 and 27. There will be a meeting at the Royal Institution at 11 o'clock on July 26 for the presentation to Dr. Perkin of the portrait, bust and addresses, and there will be a banquet at the Whitehall Rooms at 7 o'clock, at which many distinguished guests are expected to be present. On July 27 a visit will be paid

to the original works at Greenford-green where mauve was first manufactured, and there will be a garden party at Dr. Perkin's house. At 8:30 there will be a *soirée* at the Leathersellers' Hall, at the invitation of Dr. and Mrs. Perkin. The subscriptions to the memorial fund already received amount to over £2,000. Dr. Perkin was elected an honorary member of the American Chemical Society at the Ithaca meeting.

DR. D. E. SALMON, from 1884 to 1905 chief of the Bureau of Animal Industry, has accepted the offer of the government of Uruguay to organize a Bureau of Animal Industry for that country. Dr. Salmon, who is at present engaged in scientific work in Montana, will start for South America about December 1.

ACCORDING to a press despatch from Washington, Secretary Wilson, of the Department of Agriculture, has decided not to enter upon his annual vacation until he has completed the organization necessary to put into operation the new meat inspection law. He will give practically his entire time to this work for the next two months. The new pure food law also will require attention, but he intends to leave this almost wholly to Dr. H. W. Wiley, chief of the Bureau of Chemistry.

SIR FREDERICK NICHOLSON is at present in the United States in order to study our fisheries on behalf of the government of India.

WE learn from *Nature* that Sir Daniel Morris, K.C.M.G., the British commissioner of agriculture for the West Indies, has arrived in England on a short visit, and will attend the forthcoming International Conference on Hybridization and Plant Breeding to be held in London under the auspices of the Royal Horticultural Society at the end of July.

W. J. MORSE, assistant professor of bacteriology at the University of Vermont, has accepted the position of state botanist at the Maine experiment station in Orono.

MR. W. J. MEAD, of Plymouth, Wis., has been awarded the Science Club medal at the University of Wisconsin for the best baccalaureate thesis on a scientific subject. His thesis was on 'The redistribution of elements involved in the formation of sedimentary rocks.' The Science Club medal is of bronze, and has been executed by Mr. T. Moring, London.

MR. E. MASCHKE, of the geological department of Göttingen University, is desirous of obtaining fossil cephalopods, from all formations, especially from the paleozoic of North America. He wishes to exchange or to purchase them, offering in exchange German fossils and minerals. Secondarily, he wishes to obtain crinoids and trilobites.

DR. HENRY A. WARD, president of Ward's Natural History Establishment at Rochester, N. Y., was killed by an automobile on July 4. He was born at Rochester in 1834, and, after studying at Williams College and Rochester University, became an assistant of Louis Agassiz. From 1860 to 1865 he was professor of natural sciences at Rochester University. Dr. Ward's establishment rendered an important service to science by supplying specimens to museums and other institutions, and in it were engaged a number of assistants who subsequently became eminent men of science.

DR. FRITZ SCHAUDINN, recently appointed head of the parasitological department of the Institute for Tropical Diseases of Hamburg and well known for his work on the protozoa, died on June 22 from septic infection at the age of thirty-six years.

THE deaths are announced of Dr. Ludwig Brakebusch, professor of geology at Hanover, at the age of fifty-seven years; of Dr. Ledebur, professor of metallurgy at the School of Mines at Freiburg, at the age of sixty-nine years; of Dr. Robert Craik, for many years professor of hygiene and dean of the medical faculty of McGill University, on June 28, at the age of seventy-seven years, and of Dr. William Ramsden, lecturer on sanitary chemistry at Manchester University, on June 29, at the age of 29 years.

SIR JOHN BRUNNER, M.P., has given £5,000 towards the completion and equipment of the additional buildings for engineering, metrology and metallurgy now in course of erection at the National Physical Laboratory, Teddington.

A NATIONAL dairy congress is to be held at The Hague, in 1907. Among the subjects to be discussed are unification of chemical methods for the examination of milk, butter and cheese, and of milk, butter and cheese control, etc.

Nature states that a banquet was given by the Institution of Electrical Engineers on June 25 in honor of the delegates from kindred institutions in Canada, France, Germany, Italy, Switzerland and the United States who were visiting England. Mr. John Gavey, C.B., president of the institution, presided, and there were about 450 guests and delegates present. The toast of the visiting delegates, proposed by the president, was responded to by Professor J. L. Farny, representing the Association Suisse des Électriciens; Mr. P. J. B. E. Auzépy, consul-general of France; Professor E. Budde, president, Verband Deutscher Elektrotechniker; Dr. Emil Naglo, representing the president of the Elektrotechnischer Verein; Mr. S. S. Wheeler, president of the American Institute of Electrical Engineers; and Mr. Guido Semenza, honorable general secretary of the Associazione Elettrotecnica Italiana, who during his response presented to the institution, in the name of the Associazione Elettrotecnica, a bust of Alessandro Volta. A conversazione in honor of the visitors was held at the Natural History Museum on the evening of the twenty-sixth.

THE third International Conference on Plant Breeding will be held in London, from July 30 to August 3, under the auspices of the Royal Horticultural Society. Conferences on this subject were held in London in 1899 and New York in 1902. The president of the forthcoming conference will be Mr. W. Bateson, F.R.S.

THE Royal Institute of Public Health has fitted up a laboratory for the study of parasitology. Dr. Sambon has been appointed director of the parasitological department, and Dr. Giordani and Dr. Bonelli are working with him. Systematic investigations have already been started, and many interesting specimens of parasites can be seen at the laboratory. Attention is in particular be given to parasites conveyed by domestic a mals, by cattle and by rats.

WE learn from the *Scottish Geographi Journal* that an Oceanographical Museum been established at Berlin in connection w the Institut für Meereskunde. The for opening took place on March 5, in the prese of the Emperor and the Prince of Mona just five months after the death of Baron Richthofen, to whose initiative the new n seum owes its origin. The museum divided into four sections: (1) A collect illustrating the imperial navy, containi pictures and models of warships, and spe mens of guns, torpedoes, etc.; (2) a popu and historical collection illustrating the pr ress of navigation, with models of modern a primitive vessels, life-saving apparatus, a so forth; (3) a collection of instruments, e used in the study of the ocean and its c tents, with numerous models showing t height of the continents and the depth of t ocean, the weight and volume of land and s respectively, in relation to those of the wh earth, the amount of salt in the sea, and forth; (4) a collection illustrating the biolo of the ocean and the fisheries, with exampl of the products of economic value.

THE second International Congress of t Association for the Promotion of Hygie and Salubrity in Dwellings will be held Geneva from September 4 to 11. The pr gram of the congress is as follows: A, dwelli houses; B, lodgings and places of assembl C, movable and temporary dwellings; D, a and decoration in relation to the wholesom ness of houses; E, sanitary administratio The general secretary is M. Albert Wauri 1 Rue des Moulins, Geneva.

AT the meeting of the London Zoologic Society, held on June 21, the report of t council for the month of May was read b the secretary (Dr. P. Chalmers Mitchell), i which it was stated that 391 additions ha been made to the society's menagerie durin that month, of which 169 had been acquire by presentation, 14 by purchase, 25 by birt in the gardens, four received in exchange, an

179 received on deposit. The report further stated that the number of visitors to the society's gardens during the month of May had been 61,692, making the total for the first five months of the year 255,280, or an increase of 33,418 visitors as compared with the corresponding period in 1905.

WE learn from *The British Medical Journal* that at the last meeting of the Paris Academy of Sciences, MM. Calmette and Guérin made a communication on a new method of vaccination against tuberculosis, with good hopes of its ultimate applicability to the human subject. From numerous experiments, conducted with another object in view, they found that tubercle bacilli killed by heat or treated by different reagents pass through the intestinal wall with the same ease as living bacilli, and are found in the mesenteric ganglia, and even in the lungs. They therefore experimented to see if young animals (calves and kids), given by the mouth, at an interval of forty-five days, two doses of 5 and 25 centigrams of bacilli, either dead or modified in their vitality and virulence by various methods, could with impunity support a meal of 5 centigrams of fresh bovine tubercle, certainly infective for control animals. They have been able to convince themselves that bovine tubercle bacilli, killed by five minutes' boiling or simply heated for five minutes at 70° C. and ingested in given conditions, protect completely for four months at least against virulent infection by the digestive passages; how long the protection endures is not yet possible to state. Details of the actual experiments will shortly be published, but at the present time MM. Calmette and Guérin have proof that young calves can be vaccinated by simple intestinal absorption of bacilli modified by heat, and that this method of vaccination does not present any kind of danger. The experiments must be repeated in a sufficient number of animals to justify the application of the system to the prophylaxis of bovine tuberculosis. M. Roux, after this communication, announced that he is conducting experiments in collaboration with M. Vallée of Alfort on the same lines as MM. Calmette and Guérin, and that the results obtained agree in a remarkable way with those of the experiments of MM. Calmette and Guérin.

WE learn from *Nature* that in the course of an address before the annual meeting of the Linnean Society of New South Wales, held in March 28, Mr. T. Steel, the president, alluded to a proposed method of destroying rabbits by means of an infectious disease, the precise nature of which is not yet disclosed. The idea, it appears, originated in Paris, and since the necessary funds have been subscribed by stock-owners and agriculturists it is proposed to commence the experiment on a small island selected for the purpose. After discussing the arguments for and against the proposal, the president considered it highly undesirable that any such disease should be wilfully communicated to any species of animal, by means of which it might be disseminated throughout the country. As to the extermination of the rabbit, that is considered an impossible contingency; but means ought, and can, be found to keep the species in check without recourse to infectious diseases, which may be a danger to the community. In the course of the same address Mr. Steel alluded to the necessity of special efforts if the native Australian fauna and flora are to be saved from destruction. Poison spread for rabbits is responsible for the destruction of a large number of indigenous mammals and birds.

ACCORDING to the report in the London *Times* Mr. C. B. Marlay presided on June 22 at a meeting of the Royal Botanic Society, held in the museum of the society. Mr. J. S. Rubinstein protested against the system of reelecting members of the council as a matter of course; it was the result of that system that the society was in so unsatisfactory a state. The management of the society was deplorable, and he instanced the inadequate way in which its fête had been advertised. There ought, he urged, to be a properly qualified superintendent of the gardens. Prebendary Barker also spoke. He said that the chairman had not kept his promise, made at the last meeting, to send an official reply to the report drawn up by the committee ap-

pointed at the meeting held on January 24. The council had not wished the committee to receive the reply. The chairman said there had been a misunderstanding in the matter, as he had not made such promise. After a long discussion, Mr. Pembroke Stephens, K.C., announced that the reply would be sent on condition that it was kept secret until the meeting, and, on the suggestion of Mr. Cecil Raleigh, the meeting was fixed for the following Friday at 4:30, when the council met the committee. The chairman, on being asked whether the fellows were liable for the debts of the society, stated that the question was open to doubt, but he believed that in any case the liability of the individual would not be more than £15. Mr. Cecil Raleigh asked that legal opinion should be taken on the subject; at present the position was so bad that the society could not meet a demand for £500 for debentures, which had for sixteen days been ignored. The situation was precarious and serious, not only for the fellows, but for those who in the future might be elected. The accounts ought to be made up and placed upon the table. The chairman, in reply, said that the money was in the bank to meet the present call, and promised that a financial statement should be presented at the next meeting. Mr. Goodsall stated that but for the action of Prebendary Barker, Mr. Cecil Raleigh and Mr. Rubinstein, the extra guinea subscription would have been passed, and the society's finances put on a satisfactory basis.

UNIVERSITY AND EDUCATIONAL NEWS.

THE extensive and valuable collection of fossils and minerals made by James Hall, for more than fifty years state geologist of New York, has been presented to the University of Chicago by Mr. John D. Rockefeller.

AT the annual meeting of the alumni of Hamilton College, Clinton, N. Y., $20,000 was raised for the completion of New South College. Towards this sum Secretary Root, Chauncey A. Truax and Henry Harper Benedict, of New York, each contributed $3,000.

AT the Johns Hopkins University the lowing appointments have been made: Jos C. W. Frazer, Ph.D., now assistant, to associate in chemistry; Solomon F. Ac Ph.D., now Johnston scholar, to be associ in chemistry; Edward W. Berry, to be sistant in paleontology; August H. Pfu Ph.D., to be assistant in physics; Arthur Loevenhart, M.D., now associate, to be a ciate professor of pharmacology and physiol ical chemistry; William W. Ford, M.D., associate, to be associate professor of b teriology and lecturer on hygiene; M Broedel, now instructor, to be associate p fessor of art in its relation to medici Arthur W. Meyer, M.D., now assistant, to instructor in anatomy; Robert Retzer, M. now assistant, to be instructor in anaton George H. Whipple, M.D., now assistant, to instructor in pathology; J. A. English Eyst M.D., now assistant, to be instructor in phy ology; Ralph Stayner Lillie, Ph.D., Johns scholar in physiology, and Robert Er Coker, Ph.D., Bruce fellow in biology.

THE following appointments have be made at the University of Wisconsin: Seth Moody, instructor in analytical chemist Dr. Caleb A. Fuller, instructor in bacteri ogy; A. R. Johnson, assistant in organic che istry; Charles T. Vorhies, assistant in zoolo

BY the resignation of Professor E. Gregory, who has been the head of the depa ment, the chair of anatomy in the Nort western University Medical School has be recently made vacant. It is likely that t professorship, which embraces embryology a histology, will be filled during the summer.

DR. WILLIAM SHIRLEY BAYLY has resign his position as instructor in geology at Lehi University, to accept the position of assista professor of geology in the University Illinois.

ON account of the resignation of Profess L. C. Hodson, who has accepted a position the Iowa State College, the position of ass ciate professor of mining at the University Kansas is vacant.

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THE AIMS OF AN ASTRONOMER.[1]

Two titles have suggested themselves for my address of this morning, 'The Aims of a Man of Science' and 'The Aims of an Astronomer.' The objections to the more restricted title are, that those of you who do not know me might think that I was about to discourse upon the inhabitants of Mars, or give you a technical paper interspersed with mathematical formulæ of appalling length. From both of these courses I solemnly promise to abstain. The broader title might lead me into domains outside of my own studies, which are always particularly tempting to a specialist. The early aims of an astronomer must be passed over briefly to reach the more alluring field when they become, or should become, the aims of astronomy.

The first aim of a boy when he reaches manhood, and becomes an independent unit in the community, is generally to acquire money or its equivalent. This aim for a time is perfectly legitimate. He is entitled to support, food, lodging and clothing. Unfortunately, the savage has here a great advantage over civilized man. As soon as he attains his full strength and physical development, he becomes an important member of his tribe. He can hunt and fish, and can live in even greater comfort than his elders. The complex wants of civilization have changed all this. With us, a boy must get his education, and for years must be dependent on others when he should

[1] Address before the Harvard Chapter of Phi Betta Kappa.

be self-supporting. Many of the evils of socialism, hatred of the rich and fear of powerful organizations, are due to this cause.

If a man never gets beyond the money-making stage, he can hardly be called a student of science. Let us assume that he is intellectually a success and attains a college position. He will never be rich, but since he is as well off as his associates he is not poor. His next aim is likely to be personal fame—a better object than wealth, but still a purely selfish one. In this stage of his development he tries to obtain honorary membership in societies, degrees or other honors, instead of waiting for them to come to him unsolicited. He makes reclamations of priority, and deposits sealed packages in the safe of the French Academy, so that if any one else should make the same discovery he can call for his package and prove that he is entitled to the entire credit, since he was first. If he is young, he attacks the work of some older man, and thus gains notoriety, even if his charges are disproved or ignored. The specious plea, 'I feel obliged, in the interests of science, to point out that my friend, Mr. A., is entirely wrong,' seldom conceals the true motive.

The next aim is higher and is for fame, not for himself but for his college, his city or his country. Enthusiasm for his state is dampened when the latter attempts to tax scientific institutions, instead of aiding them as is done in all other civilized countries. For years nearly all English mathematicians, following Newton, dealt with fluents and fluxions, while the continental mathematicians, following Leibnitz, used differential coefficients. The astronomers who gave the principal credit to Adams for the discovery of Neptune were nearly all Englishmen, while few Frenchmen admitted the claims of any one but Le Verrier.

This brings us to what should be the true aim of the student of science, the advancement of human knowledge and the termination of the laws regulating physical universe. His sole object sh be to secure the best possible results, he must be ready to make any sacrific his personal wishes for this end. Ast omy thus becomes international, and wl impersonal. To how many of us is thi one and only aim, regardless of all se considerations? We must not expect much of poor human nature, and yet it do no harm to make our ideal a high No man is likely to surpass his ideal, even if it is so high that he can not to reach it, he may go further than i tries only to attain money or fame. The of the astronomer thus become the of astronomy, and there is no subje which he can better give careful atten

No man can hope to advance science as has been done in the past. Thin writing a book which not only would vive and be useful for two thousand y but which for fourteen centuries shou the great work, and practically the authority, of its kind. Yet this is the tion held by the Almagest of Ptol During the greater portion of this ti was reproduced again and again by la ous hand-made copies into which e crept, were repeated and multiplied. far the best copy bridges more than the interval, since it was clearly writt the uncial characters of the ninth cen It is deposited in the Bibliothèque Nа ale in Paris, and in 1883 was kept in of the show cases of that institution contains a catalogue of more than a sand stars, which is perhaps that pared by Hipparchus, nearly two cen earlier. It not only gives the posi but the brightness, of all of these stars shows that at the beginning of the (tian era the appearance of the heaven nearly the same as at present. Ev careful observer, without instrun

would have difficulty in detecting any differences during these two thousand years.

But for the errors in copying mentioned above, the Almagest would still give us valuable information regarding the secular changes in the stars. No worker in science knows whether his results will have any value a century hence. The work of the older astrologers was supposed, at that time, to be as valuable as that of the astronomers. No one could tell that the work of the early chemists was of more importance than that of the alchemists. Until within a century, the estimates of the light of the stars as given in the Almagest were considered as of little scientific value. One man of genius, Sir William Herschel, recognized the value of accurate determinations of stellar brightness, and from 1796 to 1799 he published four catalogues of 1,905 stars, covering two thirds of the northern sky. It was my great good fortune, when visiting his grandson in 1883, to discover the manuscript of two other catalogues, which when published rendered the work complete for the entire portion of the sky visible in England. For eighty years they had lain on the shelf, unknown to astronomers, and their existence was not even suspected. Although the observations had been made with the greatest care, the six catalogues were not in a form that could be used. The necessary reductions and publications of the results were made at the Harvard Observatory, and thus we were enabled to present to astronomers a catalogue of nearly three thousand stars, showing their brightness a century ago and determined with an accuracy which has only been equaled within the last few years.

These are examples of great successes by clear-sighted men of genius who little suspected how highly their work would be appreciated after they were dead. To offset this, there are whole generations of astronomers whose life work is now of little or no value. Let each man ask himself to which class his own work belongs. Only the future can decide with certainty, but we can at least improve methods, which will certainly do good and can do no harm.

Unfortunately, astronomical research has now become so expensive that large sums are required to carry it a step beyond what has already been accomplished. A word must, therefore, be said to men and women of wealth who desire to aid this science by gift. Many persons have learned how to accumulate great fortunes, but few have succeeded in giving away wisely large sums of money for scientific work of the highest grade. It is strange that a shrewd business man, who by life-long labor has accumulated a fortune, if he wishes to give it away, should not use the same skill that he did in acquiring it. When buying a mine he sends experts to examine it, and assures himself that he will obtain an adequate return. When converting his money into scientific results he should similarly satisfy himself that his plan is a good one, and that it will fill a real want.

Let us, therefore, hereafter have no needless duplication of observatories, no great telescopes that are idle, no costly expeditions which, owing to insufficient preparation and lack of proper organization, will surely bring no adequate return. Money placed in the hands of a suitable committee would doubtless be spent to great advantage. The Rumford Fund of the American Academy and the Elizabeth Thompson Fund are thus well and wisely administered. But it is pitiful to hear from men of the greatest ability their needs for apparatus, assistants, or means for publication, which can not be supplied by the few hundred dollars thus available.

One of the greatest needs of the physical sciences at the present time is a liberal fund for research, administered solely in

the interests of science, and by scientific men. Some of the members of such a committee should be active workers in science, some of them older investigators, still able to advise and judge, but lacking the energy of youth required to undertake research themselves. We have striking examples around us, even in this gathering, of suitable men who have passed the usual age of retirement. Some of them are still so active that they appear to accomplish even more than when they were younger. A fixed age of compulsory retirement sometimes leads to curious results. A Washington astronomer, when retired ten years ago, had all his work taken away from him and was not allowed to complete it, even at his own expense. His life is still full of work and original suggestions. An army engineer from Cambridge, too old to serve the government, has been for years, since his retirement, engaged in the greatest problems of his profession, including the Panama Canal. The thanks of Congress lengthens a man's professional career by ten years. An admiral came near having his usefulness prolonged for four years, since he was so fortunate as to be born on the twenty-ninth of February. One of the greatest and most active of living astronomers will soon be retired just as he has completed and has ready for his use the most perfect apparatus yet contrived for measuring the places of the stars. When the plan for compulsory retirement was introduced at Harvard I hoped that the observatory might profit by it. Any man can complete his own work much more economically than another. I pointed out that at the observatory we had much unfinished work, the time for my retirement was approaching, and I suggested that an appropriation should be made at once to complete it. The time is now much shorter, the work is still unfinished, and the appropriation has not yet been made.

A committee constituted as desc above, and having liberal funds at command, could advance astronomy in eral different ways. My sympathy out to the young man who has taken a graduate course in astronomy, has stu abroad at a great and active observa and comes home to teach in a little cou college. He wishes to continue his wo astronomical research with the new in ments and by the same methods he has learned. His college has no money such purposes, his associates do not pathize with his wishes, and his time strength are fully occupied with ins tion. He writes a pathetic letter st that if he had only a few hundred do for a certain instrument he would g give his own time to the proposed Last month I received a letter from a J priest in Buluwayo, a thousand miles the civilization of Capetown, giving me tain definite meteorological facts resu from a year's careful observation in wonderful climate. He described important observations he wished to if he only had five hundred dollars to chase a mounting for his telescope. committee would not only give such a the required aid, but also the encou ment which is often still more hi prized. The man of genius is, in n cases, sensitive, retiring, unable to pro results, or to make known his needs. must be sought, treated with tact and couraged. If transplanted to other roundings, or even if supplied with b appliances, his usefulness may cease. amount of organization would help hi fact any interference with his plan likely to spoil them.

On the other hand, a great observa should be as carefully organized and ministered as a great railroad. Every penditure should be watched, every improvement introduced, advice from

perts welcomed and, if good, followed, and every care taken to secure the greatest possible output for every dollar expended. A large part of the income is used for salaries, heating, lighting and repairs. Accordingly, a small increase in the resources will produce a disproportionate increase in the scientific results obtained. Much of the work of a large observatory is routine, studying thousands of stars in the same way, the work extending, in some cases, over many years. A great saving may be effected by employing unskilled and therefore inexpensive labor, of course under careful supervision. In this way a great increase in the results can be obtained from a moderate expenditure, and the amount can be closely estimated in advance.

The clerical work is largely copying numbers on prearranged forms, and computing in which only a knowledge of the four rules of arithmetic is needed. Such work must always be checked by an experienced assistant, and all errors detected by duplicate or triplicate computations. For such routine work we pay from twenty-five to thirty cents an hour, which is much above commercial rates for similar work. Prices are much lower in Europe, and supervision would also be cheaper there. An exhibition of wood-carving and embroidery has recently been held in Berlin. Some beautiful specimens were shown which had been paid for at the rate of half a cent to three cents an hour. Less skill would be required for much of the routine work needed in an observatory. If Asiatic labor could be employed, the prices would be still less, although the cost of supervision would be greater. In India, when tiger-hunting, the beaters go into the jungle armed only with a tin pan, which they beat violently with a stick. They thus frighten the tiger and chase him towards the tree in the top of which the bold hunter is safely seated, armed with a rifle. The beaters are paid the liberal sum of three to four cents a day, which is increased to six cents if the work is done properly and the tiger is killed. The family of the beater would probably prefer that he should engage in almost any department of astronomical research. The most savage despotism of modern times was overthrown, and peace and comfort brought for the first time to the millions of inhabitants of Central Africa, by soldiers, the greater portion of whom were paid at the rate of five cents a day.

It is not unusual for the unsuccessful to criticize those who are richer and more powerful than themselves. In some countries this is done with the aid of dynamite bombs. In others (I mention no names) it takes the form of newspaper attacks on wealthy men, corporations, trusts, insurance companies and railroads. When we begrudge the hundreds of millions acquired by Standard Oil, should we not remember how much of it was earned by the genius of the men who evolved the most perfect business organization the world has ever known? If we say that Mr. Carnegie ought to distribute his millions among his workmen, let us recall the fact that he was able to sell three pounds of steel for two cents, by giving to the Bethlehem Steel Works an administration and management of every detail, superior to that of any similar corporation in existence. A great railway system may misuse a large sum of money, and yet this is a trifle compared with the thousands of millions of dollars it brings to the country by supporting a vast community of farmers who are enabled by its aid to send the products of their farms to the markets of the world. If we apply these principles to astronomy we may expect the same advance that has been accomplished in commerce, agriculture and manufacture,

Who would object to a trust whose sole

objects would be increased production, reduced cost to the public, and no profit to those forming it? The advantages of careful administration in scientific work are illustrated in a plan I detailed at the Franklin bicentenary, a few weeks ago, A telescope of the largest size entails great expense, but might produce a collection of photographs which would furnish useful material for study to half the astronomers of the world. My plan proposed that a reflecting telescope of seven feet aperture should be mounted in the best possible location, probably in South Africa, and kept at work photographing the sky throughout every clear night. An international committee of astronomers would decide to what special work the instrument should be devoted, and the photographs, or copies of them, would be distributed throughout the world to any astronomers who would make proper use of them. Copies of any or all of the photographs would be sold at cost to whoever wished for them. An astronomer of any country, prepared to undertake a particular research, would be furnished with the best photographic material that could be obtained in the present condition of science. Means would also be provided him for making suitable measurements, for reduction of the results, and finally for publication. Any competent astronomer, however isolated, would thus be enabled to carry on his researches amid his own surroundings, as well as if he were at the greatest observatory in the world. The man best qualified to discuss the results often has very little skill, even if he has the time, to take the photographs. Conditions would thus be provided which would give the best results for each portion of the work, as in any well-organized industrial enterprise. The donor would be assured that he had supplied material for study for the most expert astronomers of all countries, instead of for those at a single institution. A careful estimate of the co carrying out this plan showed that it w be less than half a million dollars, or a one third of that of establishing an obs tory of the first class, like those now isting.

The greatest problem of all for the mittee to consider, and that which w really include all the others, would l determine which departments of astro were being neglected, and which wer ceiving attention that could better b plied to other subjects. A committee out money could accomplish little, bu moderate sum were placed at its dis with the promise of more if it were expended, astronomical science migl lifted to a new and higher plane. Su the subject selected were double Many men of genius have done exc work with small telescopes and poo crometers. Such men would be su with the best instruments they coul to advantage, and money for reco computers, and publication, if the sired it.

Various systematic examinations stars in certain regions, and brighter a given magnitude, have been made f discovery of new doubles. This should be completed for the entir both north and south, according t same system, and with similar instru and conditions. A certain minimum ber of accurate measures should be ob of all double stars. Computers of complain that many important objec neglected, while numerous superfluo servations are made of other less inte pairs. The committee would commu with observers, offering aid if they supply this want. If not, owners o telescopes would be asked to allow t be used for this work, the committe nishing the necessary micrometers a ploying young astronomers as ob

who would get their training, if possible, from experienced specialists in this class of work. Computers of orbits would be aided in the same way, and their work might thus be greatly improved in quality and increased in quantity. Directors of observatories could get most valuable advice and help from the committee, and when a new observatory was established its plan for work could thus be greatly improved. The Harvard Observatory would gladly welcome and profit by such advice.

The committee should not stop with existing problems. When a new line of research, like measuring the heat of the stars, is proposed, they should at once investigate it and, if the results are promising, test it. If it prove successful, they should carry it as far as present means permit. In this, as in securing the cooperation of existing observatories for any of the great problems now before us, there seems to be no limit to the results obtainable by a wise administration.

The donor, as well as the astronomer, must be asked to consider first the interests of science. His name would necessarily always be associated with his gift, and would he not prefer a world-wide, to a local, immortality? There must now be many wealthy men trying to find some good use for the money they can not take with them out of this life. The hardest problem will be to find an active committee with no taint of selfish dross. This taint exists even among astronomers. There is no more permanent, economical and efficient trustee than a great university with long continued and honorable traditions. As with any other wish of the donor, it could secure and enforce unselfish management, as well as efficiency.

Industrial enterprises half a century ago were in nearly the same condition that science is in to-day. May we not expect in astronomy the same advance by cooperation and organization? If donors, trustees and astronomers can thus be led to work for scientific results alone, regardless of country or personal considerations, it will be the best return I can make for the great privilege of addressing the Harvard Chapter of Phi Beta Kappa.

EDWARD C. PICKERING.
HARVARD COLLEGE OBSERVATORY.

SOME ASPECTS OF THE PANAMA CANAL.[1]

AFTER approximately six years of investigation, the selection of both route and type for a ship canal across the Isthmus of Panama is nearly completed. Although the report of the board of consulting engineers already made public is not final, it leads to the final consideration of the question in congress so that on the conclusion of congressional consideration work can be promptly begun under the adopted plan. Whether the final plan be that of a lock or a sea-level canal, the route will be the same, practically that of the Panama Railroad running between Colon on the Caribbean side of the isthmus and a point called La Boca on the Pacific side, a mile and a half west of the city of Panama.

The length of the Panama Canal is about 49 miles between 40-foot contours at low water at its termini, but the length between shore lines will be not more than 42 miles.

The topography of the Isthmus at the Panama crossing is well adapted to the construction of this ship canal, the original summit of the divide on the line of the canal being but about 330 feet above sea level. This has now been reduced to about 170 feet above mean sea level by the French excavation at Culebra. About one half of the length of the canal lies along low marshy ground on either side of the

[1] Read at the Ithaca, N. Y., meeting of the American Association for the Advancement of Science, June 30, 1906, before Section D, Mechanical Science and Engineering.

isthmus, making two natural sea-level sections, one about eighteen miles long on the northerly side of the isthmus, and the other about seven miles long on the southerly side; that on the northerly side running for the greater part of its length generally along the course of the Chagres River. This river has been one of the main features in the consideration of the canal work since the beginning of operations by the old Panama Canal Company in 1881. It is not a large river, as it has not more than about 800 square miles of watershed above Bohio, where in its flow toward the sea it leaves the rising ground and enters what may be termed the coastal plain, through which it meanders along a sinuous course to the ocean. It has even changed its course in the past at various locations in this marshy ground.

That portion of the canal route lying in the higher ground of the divide is but about 24 miles long, and but little more than three quarters of a mile of it had an original surface elevation exceeding 200 feet. The surface material is largely clay of ordinary character, slippery and easily moved when wet, but holding well in place when protected from the entrance of water. Below this covering of clay lies material of irregular character, as the entire isthmus is of volcanic origin. In the continental divide, at a depth varying from twenty to forty or fifty feet below the surface, an indurated clay, classed for purposes of excavation as soft rock, is found. This material gives place irregularly to hard rock at greater depths. Much of the rock of the isthmus is soft, although there is hard basalt in a number of places and, in one locality on the Panama slope of the divide, columnar basalt is found.

The work performed by the old and new Panama canal companies amounted in the aggregate to not far from eighty million cubic yards of all classes of excavation, of which possibly forty million cubic yar at most will be found available for t American construction of the can whether a lock plan or a sea-level plan adopted. This work extends practica over the entire canal route, with the (ception of the approach channels in t two terminal harbors, and it is nearly c tinuous. Over considerable stretches the higher ground it is little more th shallow cuts through the softer surf materials, but at the great Culebra (the material which has been excava varies from the surface clay, readily moved by steam shovels, to hard basal rock, requiring blasting by high explosi before it can be removed. All the r terial, even the indurated clay, below softer covering, requires blasting before can be excavated, although the softer p tions need the action of black powder or

Except the deep cutting at Culeb through the summit of the continen divide, the most marked work done by old French company was the dredg through the low marshy lands from Co to Bohio. There is at present a strip partially completed canal about 14 m long with a bottom width of seventy-t feet, which may be navigated by ves drawing twelve to fourteen feet, with exception of a short distance near Col Indeed, so much excavation was comple in this portion of the canal, intersect the Chagres at a number of places, t the waters of that river have abando the old bed and now flow through the p tially completed canal prism.

In the execution of any plan of ca one of the principal problems involved the control of the Chagres River dur seasons of flood. This problem has b considered so formidable in the past t some experienced engineers have hazar the opinion that the Panama Canal co never be successfully completed in cor

quence of the uncontrollable destruction that would be caused by the Chagres floods. The regimen of that river in connection with the rainfall on the isthmus has been a subject of such extensive and careful investigation that the elements entering the problem of control are now comparatively well known. Instead of the floods of the Chagres playing such a destructive part in the history of the canal, there have now been devised a number of methods of effective control, so that it can be actually demonstrated that such floods are not to be feared in any respect whatever. Indeed, if a lock plan should be adopted for construction, it would be impossible to feed the locks with sufficient water for navigation were it not for the supply offered by the Chagres River. In other words, the Chagres would play the part of a friendly agent rather than that of a vicious enemy in the maintenance and operation of the canal. While this river is subject to rapid variations of discharge, so that within a period of twenty-four or forty-eight hours it may change its character from that of a quiet, inoffensive mountain stream to a literally raging torrent, the range between low water and flood elevations is much less than in many of our American rivers. Nor are the extreme floods so formidable in character as they have sometimes been supposed. While many small floods occur every season, a high flood is a rarity, as but five have occurred within fifty years, and in no case have these high flood effects lasted more than about forty-eight hours. One of the prominent characteristics of the Chagres floods is the rapidity with which they rise, the short period of highest water and the short time required for recession to the condition before the flood began.

Records of accurate daily observations, both self-recording and otherwise, of the discharge of the Chagres under all conditions of flow have been kept for nearly twenty years, and more or less complete observations for a much longer period, so that what may be reasonably expected of the river at all seasons of the year is now fairly well known.

In addition to the discharge observations along the Chagres River, accurate rainfall records have for many years been kept for all portions of the isthmus. The amount of rainfall varies greatly both from certain portions of the year to other portions, and from one year to another. The isthmian year is divided into two parts, the wet season and the dry season. The former begins about the latter part of December and usually extends to the latter part of April, the remainder of the year constituting the dry season. During the dry season but very little rain falls; sometimes none at all for long periods. An erroneous impression may easily be received from the term wet season, which does not mean that rain falls daily, or that it often rains all day. In reality, some of the most enjoyable weather of the entire year is found in the rainy season, when there is no dust and the general temperature is agreeable. The rain falls mostly in showers, although there are continuous rain storms extending over several days. The latter, however, are not common. The average annual rainfall is not far from 130 inches at Colon and on the Caribbean side of the isthmus, but on the Pacific side at Panama the annual precipitation is only about one half as much.

These excessive rainfalls and the proximity of the two oceans produce at nearly all times an atmosphere of high humidity. The trying character of the isthmian climate is due chiefly to this feature. The temperature usually runs from 70° to 75° F. in the morning, and to 82° to 86° F. in the hottest part of the afternoon. Occasionally the temperature rises to 96° or 98°

F., but such periods of extreme heat are rare.

During the greater portion of the year the northeast trade winds blow steadily across the Caribbean Sea, so that Colon receives the benefit of the resulting winds. In fact, during the greater part of the year strong breezes are of daily occurrence in the vicinity of Colon, although these are interrupted during some portions of the rainy season.

The winds are much more gentle and far less in amount in Panama than on the northerly side of the isthmus. There are periods of gentle breezes from the north and also from southerly directions, but they are never high winds. The Bay of Panama, on which is located the city, and into which the canal will lead from the north, is so free from high winds that shipping at anchor in it never needs the protection of breakwaters or similar structures. A real wind storm of high intensity in that vicinity is practically unknown. This condition is so strongly characteristic of the Bay of Panama that many of the opponents of the Panama route have strongly argued against it for the reason that the prolonged calms and general absence of winds would make it difficult for sailing vessels either to approach that end of the canal or to leave it after having passed through the waterway.

The harbor of Colon, completely open to the north, is of a radically different character. While it is frequently visited by breezes and winds of ordinary intensity, there are not, on the average, more than three or four days at most in the year when winds are high enough to be troublesome to shipping lying there. During those three or four exceptional days, however, wind storms of great violence, called 'northers,' may blow. At such times no ship can safely lie at anchor in Limon Bay, on which Colon is located, nor can they lie berthed alongside of the piers. In l cases they are in grave danger of b wrecked. It is the universal custom ing the period of 'northers'—Novem December and January—for every fitted with power quickly to leave the of Limon and either put to sea while storm lasts or seek the small naturally tected harbor of Porto Bello, about ei een miles to the northeast from C This characteristic of the harbor of C will make necessary the constructio great breakwaters or other similar w in order to transform it into a suit terminal harbor for the Panama Cana

The report of the board of consu engineers discloses a radical divergen the views of its members. A majorit eight of thirteen members, including five foreign members, have reported qualifiedly in favor of a sea-level c having a bottom width not less than feet in ordinary section, a minimum d of water of 40 feet, and a top widt ordinary section of 270 feet except i distance of seven miles in the great Cu Cut, where the canal prism would l rock with a width of 200 feet. All sid rock excavation would be vertical. much as the maximum range of tide i Bay of Colon is never more than abou feet no tidal lock would be required a Caribbean entrance of the canal. I Bay of Panama the maximum range o may reach nearly twenty-one feet. board, therefore, assumed that a tida would be required, or at least shou planned and estimated for at or nea Panama end of the canal. This lock be located near the easterly side of Hill, not more than one half mile the shore of Panama Bay. It is des to have a usable length of 1,000 feet usable width of 100 feet.

The control of the floods of the Ch River would be effected in the ma

plan by a dam across the Chagres River at Gamboa, about thirty-one miles from Colon, near the point where the Chagres River in its downward course first cuts the canal line. At that point bed rock is about fifty-five feet below the surface of the water in the river, affording a comparatively easy masonry construction resting directly upon bed rock, and thus securing an undoubted foundation for a dam. The maximum elevation of water surface in this lake would be about 120 feet above the present surface of the water in the river at Gamboa, or about 170 feet above mean tide. The dam would be fitted with suitable controlling gates of sufficient capacity to meet the requirements of the highest floods. The available storage volume created by this lake would be sufficient to take in quick succession two of the greatest floods which have ever occurred in the Chagres River, so far as is known either by exact records or by reliable report.

It would be the purpose in this system of control to allow flood waters of the Chagres River to escape through the controlling gates into the canal prism at a maximum rate not exceeding 15,000 cubic feet per second, producing a current in the canal, if all flow should be in one direction only, of about one and one quarter miles per hour, a negligible quantity as far as its effects on navigation are concerned. It would require but two or three days after high floods in the Chagres to depress the surface of water in the lake so as to be in readiness for another flood whenever it might occur.

The only other stream of magnitude, discharging into the Chagres River within limits affecting the canal, is the Gatun River, which joins the Chagres near the little native town of Gatun, seven miles from Colon. The discharge of this river, however, would be carried into Manzanillo Bay entirely outside of the canal in an independent artificial channel on which much work was done by the old Panama Canal Company. The other and much smaller streams intersecting the canal line throughout its entire course would be either kept out of the canal altogether by dams high enough to reverse their flow into other drainage basins than their own, or received into settling basins outside of the canal and quietly discharge their small flows into the canal prism over wiers in the usual manner. All streams of this latter class, however, are extremely small. By these means all sensible amounts of silt or other heavy material carried in floods would practically be kept out of the canal, thus reducing the cost of maintenance in this respect to a small annual amount.

A minority of five of the consulting board reported their judgment in favor of a lock canal with two terminal lakes and with a summit level eighty-five feet above the mean level of the ocean. In this plan it is proposed to construct a great earth dam 135 feet high across the Chagres River at Gatun. This dam would retain a large lake backing the water in the river up to Alhajuela, a point over thirty miles from the site of the dam. The surface of the water in this lake constitutes the summit level of the lock plan. Three locks in series or flight, each with a clear length of 900 feet and a clear width of 95 feet, would be built at the site of the dam, each with a lift between 28 and 29 feet to pass vessels up from the approach channel leading to the locks from the harbor of Colon to the summit level. The southern extremity of the summit level of this plan would be at Pedro Miguel on the southerly side of the continental divide where the channel issues from the Culebra cut. At this point, between thirty-nine and forty miles from Colon, there would be located a lock with a lift of about thirty feet, connecting with the terminal lake at the

Panama end of the canal, which would have a water level of about fifty-five feet above mean tide in Panama Bay. This terminal lake would extend to another earth dam, or rather two earth dams in the vicinity of the present railroad terminus at La Boca and one embankment easterly of this location. That portion of the dam at La Boca would be built directly across the mouth of the Rio Grande River, which is chiefly a tidal estuary. A hill known as Sosa Hill would separate the two earth dams already alluded to, and in this hill would be two locks in series connecting the terminal lakes with tide water in Panama Bay. All the locks required by this plan would be built on the twin system, so that one set would always be in use if the other should be disabled or be out of use for repairs. All ships passing across the isthmus in such a canal would have to be lifted up to an elevation of 85 feet at one end of the canal and dropped down the same amount at the other.

The control of the Chagres River in the lock plan would be effected by the lake formed by the dam at Gatun. Its volume would be so large that the waters of the highest floods could be received into it and discharged through suitable controlling gates constructed in the dam without varying the elevation of the lake more than two or three feet at most. Also, the lake would act as a reservoir for the water required to feed the locks during their operation.

There are at present being built ocean steamers for the traffic between Liverpool and New York about eight hundred feet long. This fact coupled with the rapid increase in ocean steamship dimensions during the past fifteen or twenty years caused the board by an almost unanimous vote to record its judgment that locks proposed for the isthmian canal should have a usable length of not less than one thousand feet and a usable width of not less than one hundred feet, but the minority abandon this position in their plan and recommen ed the smaller locks which have alrea been mentioned.

The total estimated cost of the sea-le canal is about $247,000,000, including twenty-per-cent. allowance for continge cies, administration and engineering. T estimated cost of the lock plan with the duced size of locks is about $140,000,0 including the same twenty-per-cent. allo ance found in the above estimate of cost the sea-level plan.

In the recent examination before Senate Committee on Interoceanic Can however, it was brought out that the nority allowance for the cost of lands s merged by the terminal lakes of its p was entirely inadequate. It was sh that on the basis of prices already paid the United States government, and by new Panama Canal Company for somew similar lands, and in view of the claim ready made by alleged owners, this amo of land damage might reach an additi sum of $15,000,000 to $18,000,000, and if the excess of annual cost of mainten and operation of the lock plan over the level plan be capitalized at prevailing r of government interest the real cost of lock plan might approximate not less $175,000,000 to $180,000,000.

The question of the selection of ulti type of canal to be adopted for constru has been submitted by the Presiden Congress, and the Senate Committe Interoceanic Canals has been conductir extended examination of the entire q tion. That committee has called for dence in detail from the advocates of types of canals, but its report has no been made.[2]

The advocates of the sea-level plan

[2] Since preparing the MSS. for this artic Senate Committee has reported in favor of tl level plan, but Congress has adopted the canal.

tend that the only suitable canal across the Isthmus of Panama, commensurate with the great interests involved, especially those of the United States, is one which will permit the safest and freest passage of traffic. It is contended that there should be practically no obstruction to a free transit across the isthmus; that any canal now constructed should accommodate conveniently and freely the greatest ships afloat, and be of such a character as to admit of the easiest and most economical enlargement in the future if it should ever be required, and that the sea-level plan only fulfills all these fundamental requisites. Although there would be a tidal lock at the Panama end of the canal, inasmuch as the range of neap tides may not exceed seven or eight feet, the gates of that lock would be wide open at least one half of the time. There are hydraulic engineers of repute, who even believe that this lock would not be necessary. The majority of the board further contends that the operation of three locks in series would be a source of grave danger, indeed, a continual menace to the safety of the large ships passing them. Serious accidents caused by ships ramming the gates of both the Manchester Canal in England and at Sault Ste. Marie, Mich., show that it would be possible, and even probable, that some ship approaching the upper of these gates might ram them out of position and plunge down through the entire series.

Although the minority claim an annual capacity of sixty to seventy million tons of traffic for its lock plan, this claim has been strongly contested, and evidence brought out before the senate committee indicated that it would be more reasonable to place the maximum annual capacity at one half that amount or less.

Again the safety or stability of the earth dams, on which the very existence of the minority plan is based, has been most seriously questioned. A considerable number of borings made into the material on which it is proposed to place the Gatun dam show that the maximum depth of that material is not less than 258 feet; that it is largely sandy, and in some places gravelly and freely water bearing, *i. e.*, permeable at various depths from thirty-two feet below the surface down to nearly two hundred and fifty. These conditions, it is alleged, might lead to dangerous percolation under the dam, and so bring its stability into grave question. Somewhat similar criticisms have been made regarding the earth dam across the tidal estuary of the Rio Grande.

Although the capacity of the sea-level canal has been also criticized or questioned, that capacity was shown to be practically unlimited. Although most serious congestions of ships arriving in groups or fleets at either end of the lock canal might lead to long delays in some cases with a lock canal, it was shown that no such congestion could occur with the sea-level canal, even at the Panama end, for the half of any tidal period would permit any group of ships to pass into the canal while the gates were open.

The one hundred and fifty feet bottom width of the sea-level plan exceeds the width of even the turning out or passing places in the Suez Canal. In other words, the Panama sea-level canal would be a continuous passing place throughout its entire line. The total curvature of the sea-level plan was also shown to be less than that of the lock plan, and but little different from the total curvature of the Suez Canal. The lock plan with the large terminal lakes has the further serious disadvantage of possessing a minimum adaptability to transformation to a sea-level canal in the future. While this transformation is a possibility, the great difficulties attending it, and the excessive cost of that trans-

formation, were considered by the board as a whole to make transformation of this plan essentially not feasible.

Again, inasmuch as the canal would probably not be completed and opened within less than ten years on any plan the locks of the minority plan would not be large enough to accommodate ships then afloat if the rate of increase of ships' dimensions during the past ten years should be nearly reached during the next ten.

The time estimated by the majority to be required for the building of the sea-level canal is from twelve to thirteen years after making the most abundant allowances for the effects of climate, of the rainy seasons, of the necessary repairs and renewals of plant, of the eight-hour labor day, of the low efficiency of available labor, and without working more than one shift of labor within twenty-four hours. It is believed that the investigations of the majority show, however, that there is a reasonable probability of a sea-level canal being opened in from one to two years less time than their estimate.

The time estimated by the minority as necessary for the construction of their lock plan was ten to eleven years. As the construction of this plan involves a much higher grade of labor, and a far larger amount of so-called works of art, such as the locks, involving the making and putting in place of about 3,500,000 cubic yards of concrete, than the sea-level plan, the writer believes that a lock plan with a summit level eighty-five feet above mean tide can be executed in little if any less time than a sea-level plan.

The recent dreadful earthquake disaster at San Francisco constitutes the gravest warning in human experience of the advisability of constructing this canal in such a way as to give it the greatest degree of immunity from the results of any convulsion of nature. The isthmus of Panama is a region of rather frequent earthquak but they are not often severe. It would an act of folly, however, to ignore the l son of such an appalling catastrophe. T canal which is to be constructed across Isthmus of Panama should be of such type as to give the minimum of obstructi either natural or artificial, the greatest gree of safety not only in operation, from the effects of earthquakes, against severity of which there is absolutely no surance whatever, and the sea-level is only type which fulfills these impera requisites.

WM. H. BURR

SCIENTIFIC BOOKS.

Archeological Researches in Costa Rica. C. V. HARTMAN. Stockholm, Ivar Hæ ströms Boktryckeri, A.B., 1901. 4°, 195 488 text illus., 1 map and LXXXVII

Museum collections and special publicat derive their value from the character of field-work on which they are based. It is such material as Mr. Hartman has furni and by means of the methods he employed we may hope to raise American archeolog the dignity of a real science.

In the growth or decay of art, industry, toms, religion, there must of necessity e the time element. For this reason, sys of relative chronology play a most impo part in prehistoric archeology. A careful telligent, thorough study, therefore, of the tents of graves is absolutely indispens 'Archeological Researches in Costa Ric by no means confined to a study of b places, yet it describes fully more than graves.

Mr. Hartman's field investigations were ried on during the years 1896–97. He b his researches on the east coast with the mound and walled enclosure at Mercedes. mound is about 300 meters west of Novillo; is truncated, with diameters at and top of 30 and 20 meters, respectively. height, 6.5 m., is the same as that of the rounding wall. The purpose of the m 'seems to have been to serve as a platfor temple, for the large statues, which

placed with faces towards the rising sun.' The author suggests that a wooden structure with thatched roof may have covered the mound, while the 'flat stone walls apparently only served for enclosures.' Four human figures and one of an alligator were found at the base of the large mound. A small mound at the end of the northern stone wall was also investigated, but neither it nor the large mound was completely explored.

In the thick forest near the enclosure there were graves that had previously been opened. They were all of an oval or rectangular shape. Only after careful search in the 'thorny thicket, beneath the gigantic forest trees' were hitherto undisturbed graves discovered. "They were arranged in small groups inside a common and almost circular platform, or enclosure, usually about half a meter in height." Each enclosure was bounded by a margin of stones of various sizes. The groups, each containing from three to five graves, are described. As regards construction the graves at Mercedes all belong to one class. The walls are still in perfect condition except when interfered with by the roots of trees. Partially chipped limestone slabs form roof and floor.

Only one grave contained traces of bone. In most of them pottery was found. "The majority of these vessels show signs of wear and are covered with soot proving that they were employed as cooking utensils." Other objects found were: Charred corn and corncobs, two stone celts and a bead of blue glass. This latter being of European manufacture, gives a clue to the age of the burials (not earlier than the sixteenth century). In these regions it has been the custom to bury the dead inside the houses, so that in all probability the low platform enclosures, containing the graves described, were primarily foundations for the huts of the living.

A curious discovery was made about 100 m. from the temple mound, where the 'rains had swept away the humus and uncovered a small portion of the roof of a stone chamber, containing a lot of pottery, but no proof that it had been used as a grave.' The construction of the chamber, which differed in several respects from the graves and the amount of pottery contained therein, leads the author to look upon it as a cache.

Not the least interesting find made in the neighborhood of Mercedes was a stone-cutter's workshop. It was discovered by chance while opening forest paths in search of graves. "Over a surface of some 20 square meters and to a depth of about one meter, the soil was intermingled with chips and partly finished idols."[1]

Rains making work on the Atlantic lowlands practically impossible the highland valleys of the interior were chosen as a field of exploration, but not before investigating a number of sites known to the occupants of the neighboring haciendas. These included a stone enclosure at Williamsburg and graves at Siquirres, Sta. Rosa, Guasimo and Jiminez.

As to work in the highlands, the valley of Cartago was selected as the most promising. Near Santiago, twelve stone cists and as many grave-pits were found in a flat elliptical mound, the cists being arranged in the eastern half and the pits in the western half. The latter differ in construction from the cists, being bowl-shaped and formed of cobblestones. The cists were all quadrangular, with 'roof, sides and bottom composed of thin slabs of limestone.' In both forms of grave, a number of objects, chiefly pottery, were found.

There were no traces of bones. The graves were not long enough to admit of adult burial at full length. It is presumed that these graves were used as repositories of the bones only after removal by decomposition or otherwise of the soft parts, a presumption strengthened by the fact that 'quite small stone cists were found in several places to contain remnants of skeletons, which had been apparently deposited in them in bundles.'

The vessels in the Santiago stone cists were, as a rule, well preserved; few bore marks of use. In fact only a few are large enough to admit of practical use. They are probably symbols of larger vessels. Later researches on

[1] It was for his work on the east coast that the Loubat prize was awarded to Mr. Hartman by the Swedish Academy of Literature, History and Antiquities.

the Pacific coast brought to light a quantity of diminutive mortuary vessels.

At Chircot, a suburb of Cartago, the ancient capital of Costa Rica, was found 'a really extensive ancient burial ground, which had been left almost undisturbed.' The superficial part only of the enclosing stone-circle had been removed by cultivators of the soil. Here were 'crowded together in a small oblong space' 20 meters long by 15 in breadth, 205 graves. They were arranged in three layers. The cists of the lower, or oldest, layer were in three groups; those of the middle layer, in four groups; while the cists of the top layer were fairly evenly distributed over the whole burial ground.

The Chircot cists were in shape like those at Santiago and many were diminutive in size. In most of the cists that were of sufficient length, the 'skeletons lay stretched out on their backs at full length.' In the small cists, the bones, when present, were in heaps or bundles and often did not represent the entire skeleton. The skulls were dolichocephalic.

The mortuary vessels were not always in the cists. Many were found just outside, usually at the head end and, in a few cases, on the roof. Of the relics deposited inside the cists, the majority were in the vicinity of the head and trunk; a few were near the feet.

Objects in stone were rare. Of large, crude vessels intended for household purposes, none were found; nor any object of European origin. While the burial place must have been in use a considerable length of time, there were no cultural differences between the graves and contents of the lowest layer of burials and those of the highest. A majority of the cists contained no relics at all. In each of the others from one to five were found.

About 50 meters east of the first burying-ground a second, somewhat smaller, was found. It had been, in part, demolished. The cists that remained were similar to those of the first field and arranged in two or three layers. In the small cists were 'fragments of skeletons deposited in bundles, usually one in each cist; but in some, two or three.'

At Los Limones, 6 kilometers from Cartago, two elliptical mounds were found. They were not more than a meter high at the center, t the stone margins, if they ever existed, l disappeared.

There were 26 cists in the first mound 39 in the second. The graves were of same construction as those at Chircot, were, for the most part, without artifa Stone objects were especially rare.

Orosi, the next site investigated, is in mountains some 10 kilometers southeast Cartago. It is an ancient dwelling-p selected because of a desirable water supply adjacent stone quarries. The general gro plan shows a number of circles and semicir bordered by stones and varying in size f 8 or 10 to 20 meters in diameter. In midst of these is a rectangular space 2 long by 17 broad, surrounded by low emb ments—probably an open courtyard.

Five of the stone enclosures contai graves were excavated by Mr. Hartman. was here he found an obsidian flake—'the object of obsidian met with during all excavations in the highlands.' Obsidia also rare on the Pacific side, the author fin 'not even a single chip of obsidian' d his excavations there. One of the stone ci at Orosi was the richest in relics of any o highland mounds.

About 1,000 stone objects were coll from a neighboring coffee plantation, wh number of partially demolished stone c were still visible. In one of the cists op a golden bell was found; in another, two tubes of rolled copper. Here stood, als upright stone slab with petroglyphs.

The volume represents the results of a scientific investigations carried on first the Atlantic lowlands and later amon highlands of the interior. The cultu everywhere "that of a Stone Age peo high standing, possessed of ornaments o and copper, but with no tools or weapc metal at all." No date can be fixed f beginnings of this culture, but that it tinued to exist after the arrival of the iards is attested by the presence of glass in some of the graves.

Of native artifacts, only two imple of bone were found. The remainder w

clay, stone or metal (gold and copper ornaments only). The great majority of the clay vessels were evidently intended for mortuary purposes only. They testify to a 'highly elaborated technique and cultivated taste,' but do not include any types that come up to the best there is in Chiriqui ceramics.

Two types of ornamentation are particularly noticeable: (1) Incised geometric designs; and (2) punctate knobs resembling raised tattoo marks, or scarifications. The author observes 'that certain classes of ornament seem to have been allotted to certain classes of vessels.'

The ancient Guëtares of Costa Rica seem to have excelled in the manufacture of large multicolored bowls, a number of which have been reproduced in color, thus adding attractiveness to what even without them would be a superb series of plates.

This large quarto volume is published at the sole expense of Mr. Åke Sjögren, who has also given the collection on a part of which the work is based, to the Royal Ethnological Museum in Stockholm.

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SCIENTIFIC JOURNALS AND ARTICLES.

The Botanical Gazette for June contains the following papers: K. M. Wiegand publishes an account of his researches on the conditions of buds and twigs in winter, his observations leading to many conclusions entirely in variance with accepted notions. S. Yamanouchi publishes a preliminary account of his investigation of the cytology of *Polysiphonia violacea*, showing definitely the alternation of generations. H. F. Weiss describes in detail the structure and development of the bark in sassafras. E. J. Hill gives an account of the distribution and habits of the common oaks of the Lake region.

WE learn from *The Botanical Gazette* that a new journal, bearing the title *Annales de Biologie Lacustre*, is to be published under the editorship of Dr. Ernest Rousseau, with the cooperation of a large board of editors. The first fascicle is announced to contain 192 pages, with figures and maps. Publication is to be in German, English, French and Italian. Each volume will contain 400 to 500 pages, and the subscription price will be twenty to thirty francs. The address of the editor is Musée Royal d'Histoire Naturelle, rue Vautier, 31, Brussels.

Science Progress, published from 1894 to 1898 under the editorship of Professor Bretland Farmer and the general direction of Sir Henry Burdett, has been revived under the name *Science Progress in the Twentieth Century*. The editors are Dr. N. H. Alcock, lecturer on physiology at St. Mary's Hospital Medical School, and Mr. W. G. Freeman, F.R.S. The journal is published quarterly by Mr. John Murray. The contents of the first number are as follows: 'A Science of Commerce and some Prolegomena,' by W. J. Ashley; 'Chloroform a Poison,' by B. J. Collingwood, 'Physical Geography as an Educational Subject,' by J. E. Marr; 'On the Occurrence of Prussic Acid and its Derivatives in Plants,' by T. A. Henry; 'The Solvent Action of Roots upon the Soil Particles,' by A. D. Hall; 'Some Notable Instances of the Distribution of Injurious Insects by Artificial Means,' by Fred. V. Theobald; 'The Blood-Platelets,' by G. A. Buckmaster; 'Some Recent Progress in Chemical and Structural Crystallography,' by A. E. H. Tutton; 'The Geological Plans of some Australian Mining Fields,' by J. W. Gregory; 'The Corn Smuts and their Propagation,' by T. Johnson; 'Nehemiah Grew and the Study of Plant Anatomy,' by Agnes Robertson; and 'The Utilization of Proteids in the Animal,' by F. G. Hopkins.

DISCUSSION AND CORRESPONDENCE.

DE VRIES AND HIS CRITICS.

THE followers of Darwin in the early sixties had two difficult tasks to accomplish. One was to induce people to give the theory of natural selection an unbiased consideration; the other, and more difficult one, was to get them to understand it.

"I have often found the most extraordinary difficulty," wrote Darwin to Carpenter,[1] "in making able men understand at what I was

[1] 'Life and Letters,' Vol. II., p. 18.

driving." And as the display of mental density increased with time, he wrote to Hooker,[2] "I am inclined to give up the attempt as hopeless. Those who do not understand, it seems, can not be made to understand."

The scientific world has largely learned the first lesson—that of open-mindedness—but two recent articles in SCIENCE[3] suggest that we have not learned the other.

It is not my intention here to pose as an advocate of de Vries, nor as a self-appointed interpreter of the mutation theory. The writings of its author are too clear to need any additional elucidation. But it is important, before we discuss the theory, to be sure that we thoroughly understand it. A perusal of the articles just cited makes it difficult to believe that their authors have given the writings of de Vries a very thoughtful reading.

Calling attention at the outset to the importance of understanding the terms used by de Vries, the author of the first article says: "What we systematists have been in the habit of calling spontaneous variations or '*sports*' he calls '*mutations.*'" This is doubtless one of the commonest, and at the same time most fatal, errors to a correct understanding of mutation. 'Mutations' and 'sports' are by no means synonymous terms, as used by de Vries, and, after he has devoted several pages to carefully defining these terms, and to showing that, while mutations are a kind of 'sport,' *not all sports are mutations,* it seems difficult to understand how one who had gotten his notions of the theory at first hand could persist in the former loose usage of the terms. The distinction drawn by de Vries is clear. For example, he says,[4] "in order to avoid confusion as far as possible, with the least change in existing terminology, I shall use the term 'ever-sporting varieties' for such forms as are regularly propagated by seed, and of pure and not hybrid origin, but which sport in nearly every generation." Citing t striped variety of the larkspur as the first lustration, he continues: "Such deviatio are usually called sports. But they occ yearly and regularly,"[5] and for this and oth reasons they are not mutations.[6] Of the later.

Again our critic tells us that, "What call *individual variations* he calls '*fluctu tions.*'" And yet on page 77 of 'Species a Varieties' we read, "From a broad point view, fluctuating variability falls under t heads. They obey quite the same laws a are, therefore, easily confused, but with spect to questions of heredity they should carefully separated. They are designated the terms individual and partial fluctuatio Individual variation and fluctuation, then, not synonyms, for some fluctuations are 'p tial' and not 'individual,' and this differe is explained and illustrated in the followi twenty-three pages.[7]

On page 242[8] we are told that de Vries "pears to have been carried away with entl siasm over his discovery and jumps to conclusion that species in general origin by mutation—*and in no other way!*"[9]

'Species and Varieties' does not profe to treat at length the problem of hybridi tion, yet lecture IX. deals with the subj and on page 266 the author refers to the f that "Kerner von Marilaun pointed out fact long ago that many so-called species, rare occurrence, may be considered to h originated by a cross," and nearly a score well-authenticated illustrative examples low, with the sanction of de Vries as to hybrid origin of the species.

"And has any reason been brought forw to justify—much less necessitate—a change this belief?"[11] (*i. e.,* that differences in ch

[2] *L. c.*, Vol. II., p. 109.

[3] Merriam, C. Hart, 'Is Mutation a Factor in the Evolution of the Higher Vertebrates?' SCIENCE, February 16, 1906. Ortmann, A. E., 'The Fallacy of the Mutation Theory,' SCIENCE, May 11, 1906.

[4] 'Species and Varieties,' p. 310.

[5] *L. c.*, p. 11.

[6] Mutations are distinguished from other ki of sports, among other ways, by being 'of rare occurrence.' *L. c.*, p. 191.

[7] See also pp. 190 and 191, and lecture XXV

[8] Merriam, *l. c.*

[9] Italics mine.

[10] Cf. p. 250.

[11] Merriam, p. 247.

acter can be explained by the slow and gradual accumulation of individual variations). The whole book, 'Species and Varieties,' and the two German volumes of 'Die Mutationstheorie' at once furnish, to one who understands them aright, more than sufficient reason that the old theory must, to say the least, stand the test of the most rigid re-examination, and the crucial test of verification by experiment.

And what, pray, has 'the practically unanimous *belief* of zoologists and botanists the world over' to do with the merits of a new theory? Did they not practically all, previous to Lamarck, believe in special creation? "The old saying, *Vox populi, vox Dei*," wrote Darwin,[12] "as every philosopher knows, can not be trusted in science."

In the same paragraph, this: '* * * a species appears [*sic*] to have arisen in a slightly different way,' etc. (Of course it is an elementary species for which such a claim is made.) Why question the veracity of the author of the mutation theory by using the word 'appears'? When, since the publication of Darwin's 'Origin,' has a scientific fact been supported by a greater amount of experimentation, more carefully and more fully recorded, and not by one man only, but by several workers?

And if the critic asks, "How does it follow that 'then in truth Darwinism can afford to lose the individual variations as a basis'?"[13] the answer is: because the bottom does not fall out of the theory by such a loss. Other material remains for natural selection to work on. 'If it can be proved that a man eats beefsteak for breakfast'[14] it does not follow that, 'of course he could not have eaten bread.' But, if it were demonstrated by reiterated experiments that bread can do for a man all that beefsteak does, then the man 'can afford' to do without the steak. Or, to make a more relevant application, some men may breakfast on steak, and others secure the same ends with bread alone.

Referring to his extended field studies of plants, the critic says, "These studies have convinced *me* that with plants, as with animals, the usual way in which new forms (subspecies and species) are produced is by the gradual progressive development of minute variations."[15] Several pages of 'Species and Varieties'[16] are devoted to examples illustrating that 'long-continued selection, alone, has absolutely no appreciable effect' in changing the inner nature of a species or of a race, whereas there is experimental evidence of another factor by means of which such a change is accomplished. The beauty of experiment is that it convinces *all*, because given results may be produced by all alike at will, and 'experiments are a repetition of things occurring in nature.'[17]

When one says he has 'passed in review more than a thousand species,' we are constrained to ask, 'which, of at least three or more commonly recognized kinds of species?' Obviously, for example, the intergrading species of a genus like *Cratægus* (hawthorn), would prove nothing germane to the subject. And if the best result of this laborious examination of species is, 'without finding a single one which *appears* to have originated in this way,'[18] one recalls the fascinating account in 'Species and Varieties'[19] of 'the first experimental mutation of a normal into a peloric race.'[19] "The step from the ordinary toadflax to the peloric form is short, and it *appears* [note the word] as if it might be produced by slow conversion."[20] What a fine pseudo series one might arrange with the normal *Linaria vulgaris* and the *L. vulgaris peloria* at the extremes, connected by the ordinary fluctuating peloric variations![21] The beauty of de Vries's method is that it is possible 'to arrange things so as to be present when nature produces * * * these rare changes.'[22] In this way it is *known* (not a matter of opinion)

[12] 'Origin,' 6th Am. ed., p. 143, 1883.
[13] Merriam, *l. c.*, p. 243.
[14] Merriam, *l. c.*, p. 243.
[15] Merriam, *l. c.*, p. 243.
[16] P. 790 *et seq.*
[17] 'Species and Varieties,' p. 430.
[18] P. 464.
[19] 'Species and Varieties,' p. 473.
[20] 'Species and Varieties,' p. 465. Italics mine.
[21] Cf. also 'Species and Varieties,' p. 249.
[22] 'Species and Varieties,' p. 465.

that "The mutation took place at once. * * * No intermediate steps were observed. * * * Not a single flower on the mutated plant reverted to the previous type."

"According to *degree* of development at the time of their first appearance they [variations] may be designated *ordinary individual variations*, or *sport variations*. This is an old story."[23] Exactly! The new story is de Vries's very careful distinction between different kinds of sports.

And when one reads that "his [de Vries's] studies of plants have been mainly with species as modified by man rather than with species in a state of nature,"[24] one can not help wondering if lectures II., XII., XVI., XX. and XXIII. have been read at all.

And again when it is stated that "As a matter of fact, subspecies in nature do not occupy the same ground with the parent form, but an adjacent area," one can only wonder why a statement that may be quite true of a given group of animals (*e. g.*, birds) is made so general as to include the entire plant kingdom. In what sense, we may ask, is the term subspecies used? If by it is meant geographic variety,[25] then, of course, groups that do not occupy the same region do not occupy the same region. But the term is not used in this sense in systematic botany.

And if the mutation theory seems to any one 'burdened' 'with the additional requirement that in giving off new forms the old is not altered,' relief will come to him by indulging in a little pedigree-culture experimentation, and then digesting what 'Species and Varieties' has to say about the destruction of the unfit and the survival of the fittest (elementary) species in 'intra-specific selection.'[26]

Can it be possible that, after reading 'Species and Varieties' and the larger German work, the only source of an adequate explanation of interspecific gaps is unlimited and favorable field experience, and unlimited experience in handling specimens, etc.?[27]

"Inasmuch as sudden or sport variations are exceedingly rare[28] while slight variations are exceedingly common, does it not follow that the vast majority of species must originate from slight variations?"[29] Possibly, if it can be shown that the origination of new species is an exceedingly common affair, and a matter of frequent observation. So far as the records show, no one, up to the time of de Vries, had ever knowingly observed the origin of a new species or natural variety.

And when we read that "One might spend a lifetime in studying animals and plants in the interior of almost any of the faunal [and 'floral,' we suppose is to be understood] area without encountering transitional forms or intergrades,"[30] it almost seems as though we were reading de Vries. The mutation theory not only offers a possible explanation of this fact, but would even lead one to expect such condition.

Some ten years before the publication of 'Species and Varieties' Bateson inquired "Is it not then possible that the discontinuity of species may be a consequence and expression of the discontinuity of variation?" and then added:

> Upon the received hypothesis it is supposed that variation is continuous and that the discontinuity of species results from the operation of selection. For reasons given above (pp. 15 and 16) there is an almost fatal objection in the way of this belief, and it can not be supposed that all variation is continuous and also that the discontinuity of species is the result of selection. With evidence of the discontinuity of variation this difficulty would be removed.
>
> It will be noted that it is impossible to suppose that the perfection of a variety, discon-

[23] Merriam, *l. c.*, p. 245.

[24] Merriam, *l. c.*, p. 247.

[25] Cf. the map, p. 256.

[26] 'Species and Varieties,' pp. 741, 744, 749, 751, 800, 801, 802, 805, 825.

[27] Merriam, *l. c.*, p. 256.

[28] Ignoring again the continuous sporting of 'ever-sporting varieties,' and the distinctions between different kinds of sports.

[29] In the northern states white people are more common than black. Therefore, all the people of the northern states have originated from whites. Q. E. D.

[30] Merriam, *l. c.*, p. 256.

[31] 'Materials for the Study of Variation,' p.

uously and suddenly occurring, is the result of selection. * * * This consideration of course touches only the part that selection may have played in the first building up of the type and does not affect the view that the perpetuation of the type, once constituted, may have been achieved by selection.[32]

To say the least, the declaration that 'so far as known,' the theory of the origin of species by mutation is 'not applicable in the case of animals,' seems a rather arbitrary statement in the face of the mass of contrary evidence that exists in recent literature.[33]

Considering the volume of evidence in zoology[34] that 'distinct and perfect varieties may come into existence discontinuously,' the question forces itself, 'may not the discontinuity of species have had a similar origin?' At least the strong "presumption is created that the discontinuity of which species is an expression has its origin not in the environment," which is continuous, "nor in any phenomenon of adaptation, but in the intrinsic nature of organisms themselves, manifested in original discontinuity of variation."[35]

By a strange chance the article by Dr. Ortmann, in SCIENCE for May 11, 1906, immediately precedes one entitled 'Misrepresentations of Nature in Popular Magazines.' The history of science furnishes all too many instances of misinterpretations of *scientific theory* in *scientific* magazines. We do not recall an instance in which Darwinism (Darwin's Darwinism) has been more twisted out of shape than has the mutation theory in this latest exposure of its 'fallacy.' It would be interesting to know if the mutation theory itself would meet with such an 'emphatic' and wholesale 'condemnation' as does this misinterpretation of it.

We are told that "de Vries claims that the process of mutation forms new species, and that individual mutations (mutants) *are* species." The *title* of the English volume is 'Species *and Varieties*, their Origin by Mutation,' and one has to read only as far as the ninth page to learn that the author intends "to give a review of the facts obtained from plants which go to prove the assertion that species and varieties *have* originated by mutation, and are at present not *known* to originate in any other way," and on page 16 "Retrograde varieties and elementary [note the adjective] species may *both* be seen to be produced by sudden mutations."

And why beat about the bush and say that de Vries '*tries to* show that mutations breed true'? Why not frankly acknowledge the fact, so magnificently established by twenty odd years of painstaking experiment, and verified by other workers elsewhere, that the variations classed by de Vries as mutants do breed true?

If it is really true that de Vries 'does not know what constitutes a species,' then, indeed, do we find our faith in his work thereby increased. Who indeed, except the makers of dictionaries, does 'know what constitutes a species'? The author of the mutation theory does know, however, that 'genera and species are, at the present time, for a large part artificial, or stated more correctly, conventional groups,' and that, 'every systematist is free to delimit them in a wider or in a narrower sense, according to his judgment.'

Is it possible that one who can write, "What distinguishes species[36] from varieties is the fact that the species is not connected by intermediate or transitional forms with the closely allied species," has ever come into contact with a group like the hawthorns (*Cratægus*), or *Aster*, or the violets in botany, or the earwig (*Forficula*) in zoology? Whether this distinction 'is the one made use of exclusively (if possible)[37] by systematists, botanists as well as zoologists,' is, we believe, quite open to question. It was a consideration of the earwigs (*Forficula*) and crab (*Carcinus*) that led Vernon to state: "It is obvious, indeed, that between two absolutely dis-

[32] Bateson, *l. c.*, p. 69.

[33] *E. g.*, Bateson, *l. c.*, Vernon, 'Variation in Animals and Plants.'

[34] Space forbids citation of specific illustrations.

[35] Bateson, *l. c.*, p. 567.

[37] The meaning of the parenthesis is not clear.

[36] Meaning the systematic groups of specific value.

tinct varieties or species, and between pure monomorphic forms, all intermediate stages may exist."[38] Even Darwin considered that species, in the early stages of their history, were connected 'by intermediate gradations.'[39] Bicknell[40] has well said, 'The current ruling, more especially in vertebrate zoology, which, in view of * * * intermediates reduces to subspecies widely diverse organic forms, may well be suspected of being artificial and of attaching a fictitious importance to the mere evidences of origin which chance, perhaps, has allowed to remain unobliterated.'

Farlow concludes his paper on species by a sage remark: "I think we shall agree that in discussing the work of botanists in other departments than our own, it would not be wise to exact a rigid conformity to our individual conceptions of species, etc." It is another critic of mutation who tells us[41] that 'at the peripheries or borders' of faunal areas 'intergrades' between species[42] occur.

One who says that "de Vries has failed entirely to take notice of this fundamental [!] principle," surely can not have read that "new species and new varieties are seen to be quite free from their ancestors, and not linked to them by intermediates,"[43] and that the links between *elementary* species "often *apparently* overlap and can only in rare cases be determined on the sole ground of field observations," but that 'pedigree-culture is the method required,' etc.[44] Has the critic read: "Transitions are wholly wanting, although fallaciously apparent in some instances," as they appeared to be to Merriam,[45] "owing to the wide range of fluctuating variability of the forms concerned, or the occurrence of hybrids and subvarieties."[46]

If it is stated that de Vries "has failed * * * to show that his elementary species and his mutations" (*other* mutations, we suppose is meant) "are not connected by intermediate forms with each other," then we can not believe the writer has read the lucid definition: "any form which remains constant *and distinct from its allies* in the garden is to be considered as an elementary species,"[47] and that 'their limits often *apparently* overlap,' but may be determined by the method of pedigree-culture, though seldom 'on the sole ground of field observations.' The experimental facts were the source of the definition.

'Such intermediate forms are (indeed) recorded by de Vries himself,' together with his clear explanation of their significance. Bateson wrote over ten years ago: "We are concerned not with the question whether or no all intermediate gradations are possible or have ever existed, but with the wholly different question whether or no the normal form has passed through all these intermediate conditions."[48] One of the greatest values of de Vries's work lies in the fact that he was present when the transition took place, and gives, not a theory at all, but the record of a fact observed again and again.

If one is unable to see how de Vries can maintain that the mutations have bred true, as is stated on page 539 of 'Species and Varieties,' he has only to repeat the experiment himself to be convinced; and if it is implied, as it clearly is,[49] that *all* the mutants "were throwing off, in each generation, additional mutants," then the facts as recorded by de Vries are ignored. That mutation, however, may be a constant character,[50] just as truly as the shape of a leaf that constantly varies

[38] Vernon, *l. c.*, p. 41.

[39] Darwin, *l. c.*, p. 426.

[40] Torreya, **6**: 94, 1906. Cf. also SCIENCE, February 16, 1906, p. 257, where Cook reduces three species and three varieties of *Utethesia* to one species *because of the intergradations.*

[41] Merriam, *l. c.*, p. 256.

[42] Or should we say 'subspecies'?

[43] 'Species and Varieties,' p. 18. 'Elementary' species plainly from the context.

[44] 'Species and Varieties,' p. 18.

[45] Merriam, *l. c.*, p. 243.

[46] 'Species and Varieties,' p. 249.

[47] 'Species and Varieties,' p. 12.

[48] 'Materials for the Study of Variation,' p. 42.

[49] Ortmann, p. 747.

[50] During the mutation period of the species, if the theory of mutation periods ('Species and Varieties,' Lecture XIV.) shall finally become established, and excepting, of course, the 'stray mutations' ('Species and Varieties,' pp. 704–706).

(fluctuating variation), is clearly brought out by the author of the mutation theory. And if, in speaking of 'de Vries's contention that mutations are species,' one has in mind the units of the systematist, then it must be insisted that such is not de Vries's contention at all, nor can such a statement be wrested from the book, 'Species and Varieties,' if the context is always considered.

"However, if de Vries had claimed that species might be made out of mutations, nothing could be objected to this view."[51] Exactly! Then why the dissenting critique? Read, on page 13 of 'Species and Varieties,' the following:

> Linnæus himself knew, that in some cases all subdivisions of a species are of equal rank, together constituting the group called species. No one of them outranks the others; it is not a species with varieties, but a group consisting only of varieties. A closer inquiry into the cases treated in this manner by the great master of systematic science, shows that here his varieties were exactly what we now call elementary species.

And this on page 558: "*The first law* [*of mutation*] *is, that new elementary species appear suddenly, without intermediate steps.*"

Finally (page 459), "Hence we have distinguished between elementary species and varieties proper. THE FIRST ARE COMBINED INTO SPECIES" (of the systematist), etc. Could a clearer statement be conceived?

There is, indeed, a sense in which this is 'no new idea,'[52] but the recognition of it, and of its bearing upon theories of descent seems to be not only new, but difficult at the present day of being clearly recognized and understood. De Vries does not claim the credit of originating the idea. He proposes to found his theory, in part, upon "a critical survey of the facts of agricultural and horticultural breeding, as they have accumulated since the time of Darwin."[53]

Says our critic: "The breeding of domestic races has always (!!) been regarded as a process analogous to the one in nature by which new species are produced." When, we may be allowed to ask, previous to the appearance of the 'Origin,' had such an idea been seriously or at all generally held. If we have not access to the original, we may even learn from 'Species and Varieties,' if we read carefully, that Linnæus looked upon species as the result of special creation.[54]

The failure to take some of his statements at their face value, or at least to distinguish clearly when he is recording a fact and when he is elaborating a theory, is a peculiar feature of the criticisms of de Vries, as in the present critique, where it is stated that he 'finally obtained *more or less* pure strains.'[55] An equally peculiar and persistent feature of these criticisms is the insistence with which the author's carefully defined terms, representing equally careful and long-needed distinctions, are entirely ignored, thus giving to his statements a wholly different color than they possess in the original. *E. g.*, "Before he [de Vries] began this process of selecting and segregating, the mutations were by no means species, but only varieties." Where, from cover to cover, of 'Species and Varieties,' is any other claim made? The point is that the author very carefully states *what kind* of varieties they are, and applies to this kind the term 'elementary-species.'

Thus again, in the next sentence, "de Vries further maintains that it is the mutations and not the variations, that give rise to new species, and he thinks [*sic*] that there is a fundamental difference between them." A clear conception of the mutation theory would have resulted in some such changes as the following in that sentence: "de Vries further *gives experimental evidence* that it is the mutations, *and not the other types of variation,* that give rise to new species, and *between these kinds of variation* there is a fundamental difference." The critic might have added here, also, the statement, 'but this no new idea,' and might have quoted from Bateson:

> The existence of discontinuity in variation is, therefore, a final proof that the accepted hypothesis is inadequate. If the evidence went no further than this the result would be of use, though

[51] Ortmann, p. 747.

[52] Ortmann, *l. c.*, p. 747.

[53] 'Species and Varieties,' p. 9.

[54] 'Species and Varieties,' p. 34.

[55] Ortmann, *l. c.*, p. 747. Italics mine.

its use would be rather to destroy than to build up. But besides this negative result there is a positive result too, and the same discontinuity which in the old structure had no place may be made the framework round which a new structure may be built.[56]

And the following cautious statement from Darwin: 'We are led to conclude that species have *generally* originated by the natural selection, not of abrupt modifications, but of extremely slight differences.'[57] Their origination by the natural selection of the 'abrupt modifications' is rejected, among other reasons, because "we have *no evidence* of the appearance, or at least of the continued procreation, under nature, of abrupt modifications of structure."[58] Since the work of de Vries the last statement no longer holds true.

The critic "is unable to see where he [de Vries] draws the line between variations * * * and mutations." The following quotation seems written in anticipation of that statement: "*The relation between mutability and fluctuating variability* has always been one of the chief difficulties of the followers of Darwin.[59] The majority assume that species arise by the slow accumulation of slight fluctuating deviations, and the mutations are only to be considered as extreme fluctuations, obtained, in the main, by a continuous selection of small differences in a constant direction."

"My cultures show that quite the opposite is the fact. * * * Oscillating changes have nothing in common with the mutations."[60] "Mutations are going on in all directions, producing, if they are progressive" (they are not all alike), "something quite new every time. Fluctuations are limited to increase and decrease of what is already available."[61]

One point is stated with terse accuracy: de Vries has not only not 'solved the old sophistic problem of how much must be added to a small thing to make it a large one,' but has clearly demonstrated, in his lecture on 'The Origin of the Peloric Toad-Flax' that, so far as the origin of species is concerned, the problem is incapable of solution.

The discoverer of 'the fallacy of the mutation theory' tells us that mutations have been observed chiefly among domestic forms. If this were true, the suggestion is, not to reject mutation on this account, but to initiate extensive experiments among a wide systematic range of wild plants (and of animals also), and see if what now appears to be the case is in reality a general truth, or only an expression of limited experience.

We are told[62] that if de Vries should 'claim that species could be made out of mutations, he would be right.' Well and good. The quotation[63] has already been given. Elementary species 'are combined into species * * *.'

If the rarity of mutations[64] seems to be a stumbling-block toward accepting them as the material on which natural selection may operate, it will be wholesome to recall that the formation of new specific groups (species of the systematists) is far more rare in nature than in the writings of systematic botanists and zoologists.

Mutation has, indeed, 'always'[65] been regarded as a special form of variation, and so it is in 'Species and Varieties,' notably in lecture I., and throughout the entire book. But if 'Consequently, nothing is left of de Vries's mutation theory but the bare facts represented by his experiments,' science has been munificently enriched thereby, to say nothing of the new method of research in the study of evolution, entirely ignored by the above statement, and the contribution for which science is de Vries's greatest debtor.

"To my mind," says de Vries, "the real value of the discovery of the mutability of the evening-primrose lies in its usefulness as a guide for further work."

I may repeat, in closing, what was stated in

[56] Bateson, *l. c.*, p. 568, 1894.

[57] 'Animals and Plants Under Domestication,' p. 495. Italics mine.

[58] Darwin, *l. c.*, p. 495.

[59] 'Species and Varieties,' p. 7. Even Wallace had this difficulty. *Ibid.*

[60] 'Species and Varieties,' pp. 568–569. Cf. pp. 715, 718 and 459.

[61] 'Species and Varieties,' p. 719.

[62] Ortmann, *l. c.*, p. 747.

[63] From 'Species and Varieties,' p. 459.

[64] Ortmann, *l. c.*, p. 747.

[65] That is, since the process has been recognized and described.

the beginning. I have not attempted to defend the mutation theory of de Vries, but only to emphasize the fact that, before we criticize it, or lend to it either our dissent or assent, we must first understand it. The ink that was spilled in discussing misinterpretations of Darwinism far exceeds that poured out in recording constructive studies in evolution. Let us not make the same mistake and waste of energy in the present case.

The mutation 'theory' is still largely a working hypothesis. It is founded almost entirely upon experiment, and can be verified only by the same means. The beauty of it is that it is already reduced to a question of fact. For mere opinion and inference, and *a priori* impressions and prejudice, and inductions from field studies and comparative morphology there is absolutely no place. If one doubts the facts, let him repeat the experiments of de Vries and MacDougal and others. If he doubts that they represent a general truth, a fundamental principle in biology, then let him await the fullness of time, for it is by repeated experiment, among a wide range of groups, and *by experiment only*, that the general application must stand or fall.

And I bespeak also a candid acceptance of the facts, after they are clearly distinguished from the inferences. The latter are open to debate, but not so the former. And when a careful worker says that he obtained a given form that breeds absolutely true, and which, for reasons fully explained, he calls an 'elementary species,' by means of a certain definite and clearly explained kind of variation which he defines and names 'mutation,' let us not refer to him as 'claiming to' have done so, or to the mutant as 'seeming to' breed true.

Pregnant with significance as the mutation theory is for the systematic botanist and zoologist, its truth can never be established nor disproved by the methods of taxonomy. Comparative studies may offer worlds of evidence and multitudes of problems to test the hypothesis, but experimentation is the only possible means for the final solution.

How do species originate? A mass of facts suggests that the method is by the natural selection of fluctuating variations, combined with geographical isolation, influence of environment, and other factors. But, after all has been written, the undeniable fact remains that no one has yet ever actually observed the origin of a single species in this way.

On the other hand, the fact is just as undeniable that a definite and clearly defined type of variation, called an 'elementary species,' has been actually observed, not once, but often and by many, to arise by a process, equally well defined and definite, and known as 'mutation.' Mutations do furnish material for the operation of natural selection and all other influences that tend to establish a unit group known in taxonomy as a 'species.'

The case seems perfectly plain that the burden of proof rests with the adherents of fluctuation.

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SPECIAL ARTICLES.

A NEW FOSSIL SEAL FROM THE MARINE MIOCENE OF THE OREGON COAST REGION.

IN a bulletin recently issued by the Oregon State University, Professor Thomas Condon has given a description of an unusually interesting fossil pinniped, which was obtained by him from the Marine Miocene of the Oregon coast. It is, indeed, a happy coincidence that this nestor of Oregon geology should celebrate his eighty-fourth birthday by so interesting and important a discovery. This does not quite equal the record of the great chemist, Chevreul, before the French Academy, it is true, but it is one sufficiently rare in paleontology.

Professor Condon has kindly permitted me to make a careful study of this unique specimen, and I do not hesitate to pronounce it easily the most important find that has yet been made in this group. As far as I am aware the specimen represents an entirely new and hitherto unknown genus, intermediate in many respects between the sea lions and seals, with perhaps the most pronounced affinities with the latter, and at the same time exhibit-

ing a number of primitive or ancestral characters not found in the skeleton of any modern pinniped. He has appropriately named the new genus *Desmatophoca oregonensis*.

The age of the horizon in which this fossil was found is determined by Professor Condon to be Miocene from the association of a large number of characteristic genera of marine shells. Whether it represents the entire series of fresh-water deposits included in the Oligocene and Miocene of the interior continental region or whether it is equivalent to only a part of them can not now be determined. I think it may be safely assumed, however, to be the equivalent of the entire series, although its vertical thickness is considerably less than the contemporary fresh-water beds. The position of the fossil within the deposit was not accurately recorded but there is reason to believe that it comes from a layer which would suggest a Middle Oligocene age if referred to the interior series.

The point of greatest interest and importance in connection with the fossil under consideration is to be found in the light which it throws upon the broader question of the origin of this highly modified and almost exclusively aquatic branch of the carnivorous mammals. Hitherto an understanding of the more exact genetic connections between the Pinnipedia and the land Carnivora has proven a very obscure and perplexing problem to the morphologist, and as a result various opinions have been expressed concerning its solution. There seems, however, to have been entire unanimity of opinion in the hypothesis that the pinnipeds are descendants of some member of the land Carnivora and that their extreme modification has been due to the assumption of an aquatic habit with the attendant changes in structure necessitated by this environment.

Huxley held that the seals (using this term in its broader sense) have been derived from the bears and he attempted to point out similarities of structure between the two groups. In this view Mivart entirely concurred. The chief objections to this hypothesis are the following: The bears have now been pretty thoroughly proven by Schlosser to be descendants of the canoid or dog phylum, through *Amphicyon*, dating no further back than the later Oligocene or earlier Miocene. In the fossil seal before us we have a very distinct pinniped, at least equivalent in age to *Amphicyon* exhibiting no approach whatever to the dog or bear groups. This hypothesis may, therefore, be dismissed as wholly untenable.

The next expression of opinion on this subject was made by myself in describing the osteology of *Patriofelis*. In this publication I pointed out the large assemblage of creodont characters to be found in the skeletons of modern pinnipeds and from a careful analysis of these features in comparison with those of certain members of the Creodonta I was led to the conclusion that the seals are the direct descendants of the creodonts. I further held that the particular family among the latter which exhibits the closest approximation and furnishes the most likely ancestral beginnings thus far known is the Oxyænidæ.

Osborn, followed by Matthew and Scott, has dissented from this view and failed to discover any relationship between the creodonts and pinnipeds. Osborn's argument against the hypothesis was based wholly upon an effort to disprove the supposed aquatic or semiaquatic habits of certain of the Oxyænidæ, which he concluded were preeminently terrestrial or arboreal. Matthew's argument consists of a simple denial of the alleged relationship of the two groups. It now remains to reexamine the subject in the light of this newly acquired evidence and test the hypothesis of a creodont ancestry by this oldest and most primitive pinniped thus far discovered.

The specimen consists of a fairly well preserved skull in which the larger part of the dentition, especially that of the upper jaw, is present. The most important feature of the teeth is the evidence they afford of their derivation from a former more complex or tubercular condition. This is especially marked not only by the two- and three-rooted

manner of their implantation, but by the more complex structure of the crown of the fourth superior premolar as compared with that of the modern seals. This tooth may be said to be implanted by three roots, of which the one supporting the inner cusp is not entirely distinct at the base, at least. The crown exhibits the remains of three distinct cusps corresponding in every way to those of the less specialized sectorial of many of the creodonts. It is somewhat simpler in structure than the corresponding tooth of *Patriofelis*, but its derivation from a tooth of that character is clearly evident. The single molar, both above and below, is missing from the specimen, so that the organization of the crowns can not be determined. They were each implanted by two distinct roots. The dental formula is I. 3/2, C. 1/1, PM. 4/4, M. 1/1.

One character which is most unusual for a seal is the deep heavy horizontal ramus of the lower jaw, together with a relatively powerful symphysis reminding one at once of the corresponding parts of *Oxyæna* and *Patriofelis* among the creodonts. The impression which one immediately receives upon examination of the specimen is that of a short heavy-jawed animal. I mention this character in particular for the reason that the heavy jaw and powerful symphysis of *Patriofelis* was made the basis of an especial objection, on the part of Osborn, to any possibility of affinity between the two. The jaws of the modern seals are relatively weak and slender.

In the cranium the more important characters to be noted are the rudimental postorbital processes, the marked constriction of the postorbital region, the relatively heavy zygomatic arches and the peculiarly distinctive creodont organization of the otic region of the skull. The mastoid is of moderate proportions and the widely separated paroccipital process is unusually large and massive and projects outwards and backwards. This arrangement and unusual size of the paroccipital is one of the most distinctive characters of the creodont skull and is one not found in any of the modern Carnivora. I may add likewise that its condition in this ancient seal is almost identical with that seen in *Patriofelis* and *Oxyæna*.

The base of the skull had not been sufficiently freed from the inclosing matrix to permit of an accurate determination of the characters of this region, but I think the presence of a small rugged uninflated bulla and an alisphenoid canal may be assumed. The occipital crest is low and inconspicuous and does not overhang the occiput as in the creodonts. The brain case is large and roomy and the brain was considerably convoluted. In fact the brain case and occipital region of the skull resemble that of the modern *Phoca* closely.

From a consideration of the foregoing characters of this important specimen the following conclusions appear to be firmly and conclusively established: (1) the seals have been derived from ancestors in which the molars were tritubercular; (2) in which there were but two pairs of incisors in the lower jaw; (3) in which the true molars were early reduced; (4) in which the lower jaw was stout and heavy with a strong, heavy symphysis; (5) in which the mastoid region of the skull was identical with that of certain of the creodonts; (6) in which the postorbital process was rudimentary or wanting.

Less firmly established characters of the ancestors of the seals may be enumerated as follows: (1) Double tongue and groove articulations of the lumbar vertebræ; (2) early development of aquatic habits with consequent modification of limbs.

If next we direct our attention to the application of these characters to the known fossil Carnivora which preceded them in time, we find that it is only among the creodonts that these characters are to be met with. It, therefore, follows that a creodont ancestry is the only possible or logical solution of the problem. As to the particular family of creodonts from which the seals have been derived the evidence is by no means so clear nor conclusive. As far as now known the choice seems to be restricted to either the Hyænodontidæ or the Oxyænidæ. Of these the latter are

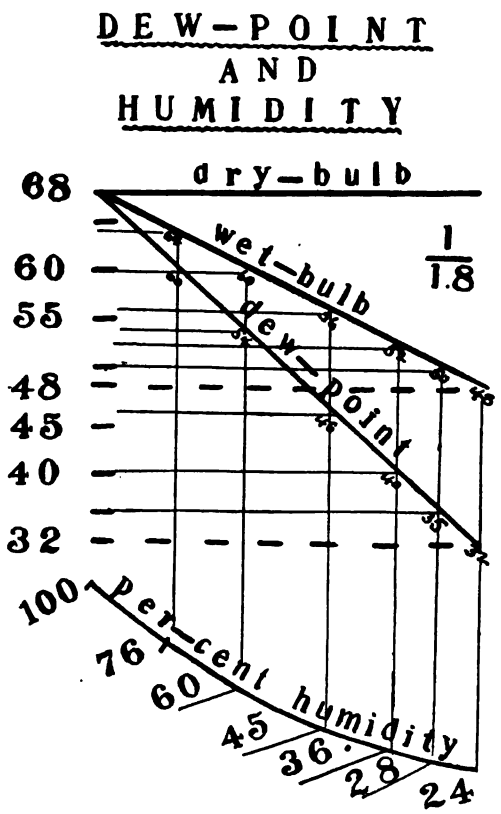
much the more likely, for the reason that all the conditions are more completely satisfied. No hyænodont is known in which the molars are reduced, whereas among the Oxyænidæ molar reduction is one of the most pronounced characters. In fact all the primitive characters are identical with those of this group. I take this occasion, therefore, to reaffirm the opinion I expressed on this subject some twelve years ago and I do so without modification or emendation.

J. L. Wortman.

McMinnville, Oregon,
June 6, 1906.

DEW-POINT AND HUMIDITY CHART.

The chart shows dew-point and relative humidity in a room whose temperature is kept at about 68°. These are readily calculated from the readings of a wet-bulb thermometer kept in the room. So long as the temperature is kept near 68°—say between 66° and 70°—the difference between the readings of the dry-bulb thermometer and the dew-point is always about 1.8 times the difference between the readings of the dry- and wet-bulb thermometers. The percentage of humidity, which corresponds approximately to these readings, is shown in the curved line below.



John F. Woodhull.

Teachers College,
Columbia University.

QUOTATIONS.

THE MOST IMPORTANT WORK IN THE WORLD.

The bringing of scientific agriculture into general practise is, we presume, the most important economic task that awaits us; and it is more than an economic task. In laboratories and on small experimental areas, methods have already been worked out which, if universally applied, would so increase the yield and the quality of our great crops, and consequently the profit of growing them, that the culture of the earth would become more profitable than commerce and manufactures. The ambitious young men have left the farms for the cities, from Abraham's day, if they had cities then, till our own, because they could make more money in trade and in similar pursuits; and the farmer, as a rule, has been the left-over man; and he will be so, till this economic situation is changed.

Great hopes were entertained a generation ago that the agricultural colleges would teach men scientific farming; and so they have; but most of the men who have thus been taught have themselves become teachers and have taught others who in turn have become teachers; and the man on the soil has, as a rule, not yet been reached with the new knowledge and with new methods.

Agricultural bulletins, too, have done good, but they have instructed those who least needed instruction; for the typical farmer does not learn farming by reading about it. Experiment stations have had a more direct influence and have caused better methods to be used in their neighborhoods.

But all these good agencies have yet failed to reach the mass of men who till the earth, the thousands and hundreds of thousands of

farmers who plow and sow and reap as their fathers did and who are suspicious of innovations, of book-farming, and of new ideas in general.

It remained for the National Agricultural Department, by a stroke of that common sense which we call genius, to begin the work of 'demonstration' on the farms of farmers who themselves work them. A report has been published by the Bureau of Plant Industry which explains the 'farmers' cooperative demonstration work' done in Texas and Louisiana under the direction of Dr. S. A. Knapp; and that is a pamphlet which seems likely to show a new hope for mankind.

The method of instructing farmers is simplicity itself. A demonstrator goes to a farmer and persuades him to do two or three such simple new things as to prepare his land in the fall or winter, to plow it deep, to practise intensive farming—that is, to cultivate it better—and to select his seed. This pamphlet is made up of reports from these 'demonstrators.' Wherever one farmer has once done these things on a small area under the direction of a demonstrator, the results have caused a change in the general agricultural practise of the neighborhood. The whole problem is to do such work in every neighborhood. These reports contain such remarks as these:

Six years ago an average yield of 30 per cent. of lint cotton was considered very good. Now we often have cotton that yields as high as 38 per cent. of lint. That alone in the cotton crop of the South means a profit of about $30,000,000. (From Palestine, Texas.)

The seed we gave out last season produced from a third to three times as much as the old varieties. At Grosbeck, where 7,000 acres of cotton will be planted this year, a good season will produce 1,000 more bales than the same acreage would have yielded planted in the old way. (From Houston, Texas.)

In 1904 I had to be very careful how I approached a farmer. He would say he cared nothing about our book farming. Now they insist on my going to see them. There is 50 per cent. improvement in our agriculture as compared with a few years ago. (From Shreveport, La.)

The area over which this kind of instruction is carried on has this year been greatly extended. If this be not education that tells, then what is? One philosophical observer of this movement has called it 'the most important work in the world.'—*The World's Work.*

OBSERVATORIES AND ASTRONOMERS OF THE WORLD.

THE Committee of Bibliography and of Astronomical Sciences of the Royal Observatory of Belgium has undertaken to publish a list of the observatories and astronomers of the world. A request for information, in the form of a list of questions, with a model reply relating to the astronomical service at the Uccle Observatory, Belgium, has been addressed to all the directors of observatories. In addition the list will include such astronomers (university professors, amateurs, etc.) who are not attached to any observatory, but are, nevertheless, actively engaged in astronomical research. The information already sent will enable the committee to draw up not only a list of observatories, with their geographical coordinates and the members of the staff, but also a table showing the astronomical activity of the world, thanks to the facts given as to the instruments at the disposal of each institution, the pieces of research undertaken, and the papers published. The directors of those observatories who have not received the question-form, or who have not yet forwarded a reply, as well as unattached astronomers, are requested to send the information desired, as soon as possible, addressed to the chairman of the committee, Professor P. Stroobant, astronomer at the Royal Observatory of Belgium, Uccle, Belgium.

ELIZABETH THOMPSON SCIENCE FUND.

THE 31st meeting of the board of trustees was held at the Harvard Medical School, Boston, Mass., on June 25. The following officers were elected:

President—Henry P. Bowditch.
Treasurer—Charles S. Rackemann.
Secretary—Charles S. Minot.

Professor Bowditch offered his resignation as trustee, since he had now withdrawn from active participation in scientific work. The

trustees expressed their reluctance to accept this resignation, because of the long and valued service of Professor Bowditch, yet they desired to relieve him of burdensome responsibility. It was voted to accept the resignation to take effect when through correspondence a successor has been elected.

The secretary reported that on December 12, 1905, a grant of $1,000 had been awarded to Professor Angelo Mosso for the establishment of an American table at the International Mountain Laboratory, founded by Professor Mosso under the auspices of the Italian government, on the Col d'Olen of Monte Rosa. It was specified that appointments to this table should be made by the trustees of the Elizabeth Thompson Science Fund. Of the sum granted, $500 was received as a special contribution for this purpose from the Bache Fund of the National Academy of Sciences in Washington.

It was voted to close the records of the following grants, the work having been completed and publications made: No. 60, F. Kruger; No. 110, H. S. Grindley; No. 114, W. Rosenthal; and to close upon receipt of publication grant 113, made to S. P. Fergusson.

Reports of progress from the following holders of grants were received:

No. 94. A. M. Reese.
" 96. H. E. Crampton.
" 98. J. Weinzirl.
" 101. T. A. Jaggar, Jr.
" 103. E. Anding.
" 105. H. Kronecker.
" 106. W. Valentiner.
" 107. M. Travers.
" 108. B. L. Seawell.
" 109. A. Nicolas.
" 111. R. Hürthle.
" 115. H. S. Carhart.
" 116. W. Bateson.
" 117. E. Salkowski.
" 118. Th. Boveri.
" 119. J. P. McMurrich.
" 120. E. H. Archibald.
" 121. A. Debierne.
" 122. J. J. Frič and Fr. Nušl.
" 123. E. C. Jeffrey.

No report was received from Professor P. Bachmetjew concerning grant 124.

The treasurer announced that $1,300 was available for new grants. It was necessary to decline several applications which the trustees would have favored if the resources had permitted. The following new grants were made:

No. 126. $250 to Professor L. Cuénot, Nancy, France, for researches on heredity in mice.

No. 127. $250 to Professor E. Wiedemann, Erlangen, Germany, to study the behavior of gases at high temperatures for astrophysical purposes, and to determine their illuminating value.

No. 128. $50 to Dr. L. J. Henderson, Boston, Mass., to study the compressibility of muscle.

No. 129. $50 to Dr. G. W. Hall, Boston, Mass., to investigate the oxidation of glucose and allied substances in the organism.

No. 130. $125 to B. G. Smith, Esq., Ann Arbor, Mich., for the study of the embryology of *Cryptobranchus*.

No. 131. $100 to Dr. F. W. Thyng, Boston, Mass., to complete the study of a human embryo of 13.6 mm.

No. 132. $200 to Professor W. G. Cady, Middletown, Conn., to investigate the electric arc between metallic electrodes.

Final action regarding the application of Dr. H. H. Field, concerning the card catalogue for physiology, was postponed.

Charles S. Minot,
Secretary.

SCIENTIFIC NOTES AND NEWS.

Professor van't Hoff, of Berlin, was elected an honorary member of the German Chemical Society at the recent meeting at Nuremberg.

Lieut.-Colonel D. Prain, F.R.S., director of the Royal Gardens, Kew, and late director of the Botanical Survey of India, has been appointed a Companion of the Order of the Indian Empire.

M. Gernez, professor of general chemistry in the School of Arts and Manufactures, Paris, has been elected a member of the Academy of Sciences, to succeed the late M. Curie.

Jesse B. Mowry, B.S., has been appointed, by Governor Utter, commissioner of forestry for Rhode Island.

DR. E. ANDING, professor in the University of Munich, has been appointed director of the Ducal Observatory in Gotha.

M. JANSSEN, director of the Astrophysical Observatory of Meudon, Paris, will represent the Paris Academy of Sciences on the occasion of the celebration of the fourth centenary of the University of Aberdeen, on September 25.

PROFESSOR NOAH K. DAVIS, who is now seventy-six years of age, has retired from the active duties of the chair of moral philosophy in the University of Virginia.

AT an assembly of the faculties of University College, London, on July 4, Dr. Carey Foster, emeritus professor of physics and former principal of the college, was presented with his portrait, painted by Mr. Augustus John.

THE former pupils of Dr. Hallaran Bennett, professor of surgery in the School of Physic, Trinity College, Durham, and for forty-five years a member of the teaching staff, have established a medal to be awarded in his honor, and will place a bronze life-size relief portrait in the school and in Sir Patrick Dun's Hospital.

AT a meeting of the officers and council of the Norwegian Geographical Society, in Christiania, on May 19, the gold medal of the society was awarded to Dr. Carl Lumholtz for his scientific explorations. The medal will be presented to Dr. Lumholtz in September, on his arrival in Christiania.

THE Longstaff medal of the London Chemical Society has been awarded to Professor W. N. Hartley, F.R.S., in recognition of his spectrochemical investigations.

SIR LAUDER BRUNTON, Dr. J. C. McVail, medical officer of health for the counties of Stirling and Dumbarton, Dr. A. Macfadyen, of the Lister Institute, and Dr. T. A. Starkey, professor of hygiene, McGill University, have been elected fellows of the Royal Sanitary Institute.

The Journal of the American Medical Association states that Professor C. F. Schatz, the eminent German obstetrician and professor of gynecology at Rostock, was accused of misappropriating several thousand dollars of hospital funds. He insisted on a thorough investigation, and the trouble was found to be the result of a clerical error in auditing the accounts of the hospital. He has resigned his connection with the university and will devote himself to private practise.

DR. C. S. PRINGLE, keeper of the herbarium of the University of Vermont, has started on his twenty-sixth annual journey to Mexico for botanical exploration. He expects to return to the university in the autumn and make a distribution of the plants collected during the past year.

AN expedition has been sent by the Peabody Museum of Archeology of Harvard University to northern New York to explore an ancient Iroquois site, in continuation of the work of the past two years in that state. Mr. M. R. Harrington, of Columbia University, who received his archeological training under Professor Putnam, will be in charge of the expedition. Mr. Irwin Hayden, a graduate student in the division of anthropology, will be Mr. Harrington's assistant. Mr. Ernest Volk will be engaged for a portion of this season to continue the investigations relating to the antiquity of man in the Delaware Valley, where a careful examination will be made of the glacial deposits near Trenton, N. J. For the past seventeen years Mr. Volk has been associated with Professor Putnam in carrying on this research.

Nature announces that it is proposed to establish some permanent memorial of the late Professor W. F. R. Weldon, not only of the man himself, but also of the movement with which his name is especially associated, the application, that is, of exact methods of statistical inquiry to the study of variation and kindred problems in zoology. It has been suggested that the memorial should consist of a portrait—medallion or bust—in the museum at Oxford, a cast of which might be placed in University College, London, and of a prize to be awarded periodically to the author of the most valuable biometric publication of recent date. The committee will arrange that sub-

scribers may eventually purchase a reproduction of the portrait. Contributions may be sent to Dr. G. C. Bourne, Savile House, Oxford; Dr. G. H. Fowler, 58 Bedford Gardens, W.; Professor Karl Pearson, F.R.S., University College, W.C.; Mr. Adam Sedgwick, F.R.S., Trinity College, Cambridge; or to the Weldon Memorial Account, at the Old Bank, Oxford.

A MONUMENT in memory of Professor Nocard was unveiled recently in the Veterinary School of Alfort by M. Ruan, minister of agriculture.

SEÑOR MANUEL GARCIA, the well-known teacher of music, and eminent for the invention of the laryngoscope, died in London, on June 30. It will be remembered that the hundredth birthday of Señor Garcia was celebrated on March 17, 1905.

THE death is announced of M. Rayet, director of the observatory and professor in the University of Bordeaux.

DR. PHILIP OSSIANNIKOW, professor of anatomy and physiology at the University of St. Petersburg, died on June 11, at the age of seventy-nine years.

A NATIONAL ACADEMY OF SCIENCES has been established in Japan. It will contain forty members, of whom fifteen are to be nominated by the government and twenty-five elected.

THERE will be an international conference on cancer research in connection with the opening of the Institute for Cancer Research at Heidelberg, on September 24.

THE offer of the New York Zoological Society to the government to provide a herd of buffaloes for the Wichita Forest Reserve, in southwestern Oklahoma, has been accepted. The society will supply a herd of between fifteen and twenty buffaloes, and the government will fence in a suitable range on the game reserve. For this purpose an appropriation of $15,000 was included in the agricultural bill.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. CLARENCE H. MACKAY and Mrs. John W. Mackay have given $100,000 to the University of California, to endow the chair of electrical engineering. It will be known as the John W. Mackay, Jr., professorship, in memory of Mr. Mackay's brother, and will be filled by Professor C. L. Cory, head of the department of mechanical and electrical engineering.

THE newly-organized School of Forestry of Colorado College will begin work at the opening of the college term in September. The courses in engineering, chemistry, physics, geology and biology will be given at the college in Colorado Springs. The instruction in forestry proper will be given partly in Colorado Springs and partly in Manitou Park, a forested area of 13,000 acres, situated in the mountains at a distance of twenty miles from the city. This tract has been recently presented to the college for the use of the School of Forestry, and a number of cottages have been provided for the instructors and students.

DR. GEORGE E. FELLOWS, president of the University of Maine, has declined the offer of the presidency of the Pennsylvania State College.

DR. JAMES LOUDON has, on the ground of ill health, resigned the principalship of the University of Toronto.

DR. RAYMOND PEARL, instructor in zoology at the University of Michigan, has been appointed instructor in zoology at the University of Pennsylvania.

LOUIS M. TERMAN, Ph.D. (Clark, 1905), principal of the San Bernardino High School, California, has been appointed professor of pedagogy at the State Normal College at Los Angeles.

C. S. MYERS, M.A., M.D., has been appointed professor of psychology at King's College, London. At the same institution H. S. Allen, B.A., B.Sc., has been appointed senior lecturer in physics.

PROFESSOR ALBERT NARATH, of Utrecht, has been appointed professor of surgery in the University of Heidelberg, to succeed Professor Czerny, who has retired to take charge of the new Cancer Institute.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JULY 27, 1906.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

TECHNICAL EDUCATION IN RELATION TO INDUSTRIAL DEVELOPMENT.[1]

THE industrial development of the United States has created a demand for men with a technical education. The presence in the community of men with a technical education contributes to the more rapid development of our industrial enterprises. Each factor is at once a cause and a result and neither could be most effective without the other.

The history of industrial development and of industrial education are naturally inseparable. They must be treated together if one would understand their interdependence. It was never intended by the mother country that her New England colony should ever engage in manufacturing.

The Earl of Chatham once said that the Colonists had no right to manufacture so much as a single horse shoe nail.

In 1750 a law was passed by parliament which prohibited the 'erection or continuance of any mill or other engine for slitting or rolling iron, or any plating forge to work with a tilthammer, or any furnace for making steel in the colonies under penalty of two hundred pounds.' Every such mill, engine, forge or furnace was declared a common nuisance which the governors of the province were bound to abate. The real cause of the revolution is to be found in the discontent of the colonies with such legislative oppression.

The war of the revolution, stopping all

[1] Commencement address, June 14, 1906, at the Worcester Polytechnic Institute, by Mr. Charles G. Washburn, president of the corporation.

imports from Great Britain, revived such domestic industries as had formerly existed.

Upon the return of peace in 1783, the influx of foreign goods threatened our manufacturing industries with ruin. The revolution had been successful, but had failed of its ultimate purpose. The establishment of a national government was essential to the maintenance of manufactures, the division of the powers of government among thirteen sovereign states made a uniform revenue system impossible. The manufacturers, mechanics and tradespeople wanted a federal constitution and their influence compelled its adoption by Massachusetts. The event was celebrated by processions all over the country and on one of the banners in Philadelphia was inscribed the motto:

> May the union government protect the manufacturers of America.

The first Congress justified this hope by imposing duties which should protect manufacturing enterprises, which may be considered as the result partly of the revenue laws of 1789, partly of the embargo in 1807, and of the restrictive measures and of the war of 1812 that followed. How little the idea that we should ever become a great manufacturing nation was held by our people may be gathered from correspondence between Benjamin Franklin and John Adams in 1780, in which Franklin said:

> America will not make manufactures enough for her own consumption this thousand years.

and Adams replied:

> The principal interest of America for many centuries to come will be landed and our chief occupation agriculture. Manufactures and commerce will be but secondary objects and always subservient to the other.

The feeling of skepticism in regard to the introduction of mechanical and other improvements was not confined to this country.

Admiral Sir Charles Napier fiercely opposed the introduction of steam power into the royal navy, and one day exclaimed in the House of Commons,

> Mr. Speaker, when we enter her Majesty's naval service and face the chances of war, we go prepared to be hacked in pieces by cutlasses, to be riddled with bullets, or to be blown to bits by shots and shell; but Mr. Speaker, we do not go prepared to be boiled alive.

Yet in a few years Sir Charles Napier found himself in command of the largest steam navy that the world had ever seen.

George Stephenson, the eminent engineer, spoke of the probability of steamships crossing the Atlantic. 'Good heavens! what do you say?' exclaimed Lord Stanley, rising from his seat. 'If steamships cross the Atlantic I will eat the boiler of the first boat.'

In more recent years a lord chancellor, even after he had seen a theater illuminated without candle or oil, poured ridicule on a scheme for 'supplying every house in London with gas in the same manner as they are now supplied with water by the New River Co.' Again, so eminent a chemist and gas specialist as Sir Humphry Davy himself is alleged to have said on one occasion that it was as reasonable to talk of ventilating London with windmills as of lighting it with gas.

The Academy of Sciences in France when consulted by Napoleon at the beginning of the century as to the steamboat spoke of it as a 'mad idea, a gross error, an absurdity.' When Fulton's first steamboat made the trip from New York to Albany in 1807, it happened to be the seventeenth of August, which caused many preachers to curse the machine, on the ground that seventeen was the total of the horns and the seven heads of the beast of the Apocalypse.

It was not until after 1830 that our manufactures developed, for it was not until 1835 that the construction of our

railways was vigorously commenced or that steam was availed of to any considerable extent for motive power. Meantime and from the first the cause of education had never been neglected in New England. In 1636 the general court of Massachusetts Bay, which met in September of that year, appropriated £400 towards a 'school or college,' and in 1638 John Harvard left half of his property, amounting to about £780, and all of his books, about 300 volumes, to the institution which thereafter was known as Harvard College.

For many years, indeed as late as 1850, the common school, the academies, high schools and colleges were the only instrumentalities of education in this country.

But it must not be thought that the need for a different training had not been early recognized. It was pointed out as early as 1830 that instruction in natural science could only be found in the colleges which were designed to educate those who were intended for the professional life of the ministry, the bar and medicine, and regret was expressed that no educational training had been provided for those who proposed to occupy themselves with practical affairs, and it was pointed out that those who had signalized themselves by making great inventions had been self-educated men. The inventive faculty of our people had already been at work. John Fitch, Oliver Evans and Robert Fulton had long since demonstrated that steam was to be the great motive force for land and water vehicles.

Amos Whittemore had produced the carding machine; Eli Whitney, a Worcester County boy, had invented the cotton gin. Thomas Blanchard, of Millbury, had invented, among many other ingenious and useful devices, a lathe for turning irregular shapes. Erastus Bigelow, born in West Boylston, invented, before he was fourteen, a hand loom and machine for making piping cords, and the first power loom for making counterpanes, coach lace, Brussels and Wilton carpets and wire cloth, and laid the foundation of the prosperity of the neighboring town of Clinton.

Elias Howe, of Spencer, invented the sewing machine, and Morse had invented the electric telegraph.

In view of all these and scores of other inventions, it is not surprising that the attention of thoughtful men was directed to the fact that the development of our industrial enterprises was a matter of prime importance to the prosperity of the country, and that some special training should be provided for those who were to engage in such occupations. It is true that under the patronage of our colleges, scientific schools had been established through the generosity of private individuals. Abbot Lawrence, of Boston, founded the Lawrence Scientific School of Cambridge in 1848. Joseph E. Sheffield, of New Haven, endowed the Sheffield Scientific School of Yale in 1847, and Abiel Chandler, of Walpole, N. H., endowed a separate department of technology at Dartmouth in 1852. These schools, however, all taught pure science. It was left for the polytechnic school as later developed to teach applied science. Such, in a general way, were the conditions in 1860.

July 2, 1862, Congress passed a bill granting to each state 30,000 acres of land for each senator and representative in Congress for the purpose of endowing institutions for teaching such branches of learning as are related to agriculture and the mechanic arts, and this, too, at a time when the failure of the peninsular campaign against Richmond had left the people of the country in a state of deep depression. This gave a great impetus to the cause of technical education.

The Massachusetts Institute of Technology was opened to students in 1865.

The foundation of our own school came about in this way. In the year 1865 John Boynton, of Templeton, in this state and county, placed in the hands of his former partner, David Whitcomb, of Worcester, the sum of one hundred thousand dollars for the endowment of a free school, which was to be located in Worcester if the citizens of Worcester should provide the land and suitable buildings. This condition was complied with by a gift of the land and of $61,111 contributed by two hundred and thirty-two individual names and from twenty shops and factories. The institute was incorporated May 9, 1865, under the descriptive and perhaps prolix title of Worcester County Free Institute of Industrial Science, which was changed in 1887 to the name which the institute now bears.

December 2, 1865, Ichabod Washburn, of Worcester, offered to establish a machine shop as one of the departments of instruction of the institute.

The selection of the location of the school was an appropriate one. Worcester, then a city of 30,000, had long been famed for her industries and for the intelligence and public spirit of her citizens. Her industrial growth had taken place since 1830, prior to which time her manufactures had been of the most primitive sort. The Rev. Edward Everett Hale, whose life work, happily not yet concluded, has been so productive of good to his fellow-men, told me that Judge Merrick, a resident of Worcester, once met Samuel Slater, the pioneer cotton manufacturer, on the street in Worcester. Judge Merrick said to Mr. Slater:

> We shall never be a manufacturing town in Worcester because we have so little water power.

Mr. Slater said in reply:

> Judge Merrick, you may live to see the time when Worcester will need all the water of Mill Brook to provide the steam for her steam engines.

This conversation must have occurred at some time prior to 1835 and perhaps about 1830.

It is difficult to realize that William A. Wheeler, of Worcester, who is credited with having installed in 1825 the first steam engine in the state west of Boston, should have discarded it and used horse power until 1840, when he put in another engine. William T. Merrifield at the same time put in an engine of from four to six horse power. These were probably the first efficient steam engines in Worcester.

An indication that this was congenial soil in which to plant an institution like ours is found in the formation of the Mechanics' Association, first attempted in 1819, and successful in 1841. The object of the association was:

> The moral, intellectual and social improvement of its members, the perfection of the mechanic arts, and the pecuniary assistance of the needy.

Another object was the holding of an annual fair for the exhibition of the mechanical products of the city, and the first fair was held in September, 1848.

In July, 1854, in commenting upon the association and its work, the statement was made that:

> Notwithstanding the inadequate supply of water power which is everywhere deemed so essential for the successful development of the mechanic arts, without the aid of a single act of incorporation, mechanical business has increased in this city by individual enterprise alone more than tenfold.
>
> The mechanics as a class are more enlightened than formerly, their course is onward and upward; they are not only increased in numbers, but continually expanding in influence and usefulness.

Ichabod Washburn was very much interested in this association, and eight or ten years before the founding of the institute had discussed with the Rev. Dr. Sweetser the feasibility of establishing a school in connection with the Mechanics' Association for giving scientific instruction to mechanics in the fundamental principles of me-

chanics and chemistry. It was expected that funds for the enterprise would be contributed by the prosperous mechanics and manufacturers of Worcester. The financial panic of 1857 prevented the execution of this plan, and Mr. Washburn later decided to carry out his earlier conceived purpose in connection with the institute.

Fortunate, thus in its foundation and its location, the institute began its life under the happiest auspices. In one particular its scheme for education was unique in combining with the studies ordinarily pursued in technical schools, manual labor in a shop, run upon a commercial scale and producing articles to be sold in the market.

Unsuccessful experiments in thus combining the practical with the theoretical had previously been made in Germany and Austria.

At this point I am led to inquire just what sort of a school this was in 1865, and what its founders expected of it. I understand that in the definition of the present day a trade school aims to give the pupil a thorough, practical knowledge of some handicraft. In the manual training school instruction is given in various kinds of work with tools for educational discipline. In the technical or engineering school the sciences are taught in their practical application to the various industries.

Mr. Boynton, in his letter of gift which was prepared under the advice of the Rev. Seth Sweetser, of Worcester, and Judge Emory Washburn, of Cambridge, adopted in most comprehensive form the curriculum of the scientific school as then known, with the addition of some subjects not ordinarily included.

Mr. Washburn's final letter of gift and instruction, dated March 6, 1866, discloses a purpose to establish a trade school as we now understand it, excepting that in addition to learning a trade the apprentice was to be instructed in the principles of science.

Dr. Charles O. Thompson, the first president of the faculty, of brilliant accomplishments and magnetic personality, in his inaugural address delivered at the institute November 11, 1868, said, among other things:

> Add to these considerations the fact that boys whose faculties are kept constantly alert by the training of the school are in a condition to learn faster than others the practical application of science and that the time spent in the shop will serve the double purpose of instruction and physical exercises and it will be admitted that this form of a manual labor school is at least an experiment worth trying.

The late Senator George F. Hoar, one of the charter members of the board of trustees, always untiring in his efforts in behalf of the institute, and whose memory should always be held in most grateful remembrance by us, in addressing a committee of the Massachusetts Legislature, February 11, 1869, urging an appropriation of $50,000, said, among other things:

> You can not find an instance of a boy who has been educated in the Scientific School at Harvard College going back to the bench of the workman or the farm, and so of the Institute of Technology. Theirs will be a different, and in many particulars a higher education than ours. * * * You will not find there any boys who, having studied for two or three years, are going back to work in the shop * * * and there they will work their way up from the journeyman to the foreman and then the master mechanic.

All this testimony leads, I think, to the conclusion that the institute in 1865 was what would now be considered a combination of a scientific school and a trade school, and of a grade not as high in some respects as either the Scientific School at Harvard or the Institute of Technology in Boston.

It was frankly admitted that it was an experiment, and attention was called at the time to the fact that at Berlin the workshop connected with the school had been tried and abandoned twice. But the experiment

succeeded here, and the combination has now taken the permanent form of an engineering school of the first rank, peculiar in this respect, in which we believe it to be superior to all others, that the practise not only illustrates the scientific principles taught in the school, but also gives the students considerable experience in the use of tools and a practical knowledge of the workings of a commercial shop.

Since the founding of the institute, technical schools have been springing into existence with great rapidity in response to a constantly increasing demand for trained engineers. In speaking of this fact, President Eliot said in 1905:

> It is also true that separate schools have been set up in many parts of the country to train young men for the technical and scientific professions, but in time these schools are likely to be transferred to neighboring universities or to content themselves with training men for the lower grades of these professions, the universities all over the country being sure to appropriate the training of young men for the higher walks of the scientific professions and of business. * * * It is obvious that the policy of the American universities now under consideration has had, and is going to have, a strong effect to uplift the relatively new professions, like those of engineering, applied chemistry, architecture, music, mining, forestry, the public service and large scale manufacturing. These are highly intellectual occupations not yet universally recognized as on a level with divinity, law and medicine. The American universities will in a few generations put them all in their higher grades absolutely on a level with the older callings.

This is an interesting prophecy, but so far as it relates to the absorption of existing independent technical schools by the universities is not likely to be immediately fulfilled.

That the Worcester Polytechnic should have developed into an engineering school is a cause of great satisfaction. Progress and growth characterize all successful educational institutions. Listen to this statement:

> After God had carried us safe to New England and we had builded our houses, provided necessaries for our livelihood, reared convenient places for God's worship and settled the civil government, one of the next things we longed for and looked after was to advance learning and perpetuate it to posterity, dreading to leave an illiterate ministry to the churches when the present ministers shall be in the dust.

Such was the modest purpose of the founders of Harvard College. If the founders of this school should have the power to see us, as perhaps they have, how small their surprise compared with that of the fathers who behold Harvard University with an endowment of $18,000,000, and a student body of 4,000 being trained for most of the occupations, professional and industrial, necessary to the progress and prosperity of the nation. Contrast the first graduating class of seven with the last commencement, when 1,073 degrees were conferred. Compare the sphere of usefulness of the first president of Harvard with that of the distinguished educator who now occupies that position and who is sought to take part in the discussion of the rights of capital and labor, the proper management of corporations and kindred practical questions, to the great profit of his countrymen.

During a period of thirty years there has been a steady development in all of the departments of the institute, and the enlargement and the enrichment of the various courses has kept pace with rapidly increasing demands.

In the field of mechanical engineering this development has usually been in response to some special requirement.

The demands for power for the generation of electricity and for marine work have led to the present efficient and well-developed high-pressure steam boilers and engines, together with all the auxiliary power-house apparatus. This has also resulted in the perfecting of the steam turbine for commercial purposes, while cheap-

er power has been provided by the gas engines and producers, and, with the aid of electrical transmission, water power is also the basis of great power plants. Large wheels, higher speeds, better regulation and more efficient results are some of the new requirements which are being met in hydraulic work.

The problems in connection with the handling and transportation of materials have made great demands on the mechanical engineer and have resulted in improved hoisting machinery, conveyors, cranes, elevators, larger and more efficient locomotives and cars.

On the manufacturing side the demands have been fully as great, competition requiring more rapid and economical methods of production. These have been met by better and more powerful machine tools, automatic machinery, jigs and interchangeable parts, and within the last few years the introduction of high-speed steels for rapid work and surface grinding. Rolling-mill machinery has kept pace with the requirements for structural steel, while the response to the calls for strong and light parts for the bicycle and automobile has made possible the present perfection of these machines. The rapid development of machine molding in the foundry has come from the demand for cheaper and better castings. The further reduction of factory costs has led to the study of shop management, where every movement of worker and material is considered with an idea of reducing the cost of production.

While there have been no startling discoveries along mechanical engineering lines, there has been a continual evolution toward greater and more efficient production of power and of commercial products.

As illustrations of practical results attained may be mentioned the fact that an indicated horse-power can be produced to-day with one third the coal consumption of thirty years ago.

While in the important art of wire rod rolling, in the development of which the oldest and a most highly respected member of our board of trustees and graduates from this school have had a very conspicuous part, the tonnage output has been increased twentyfold and the cost per ton for rolling has been greatly reduced. In the year in which the first board of trustees was organized, wire manufacturers in Worcester were importing Swedish iron billets which were rolled in South Boston at a cost of $1 per 100 pounds. To-day steel billets can be rolled for 12½ cents per 100 pounds.

In the department of civil engineering the training in 1870 was confined to pure mathematics, surveying and a very limited application of theory to practise; what would now be regarded as rudimentary.

To-day the student must receive a thorough training in mathematics, physics, theoretic and applied mechanics; he must be well grounded in the elements of chemistry; and familiar with all the principles of bridge construction, and the framing of great buildings; he must possess intimate knowledge of materials, stone, brick, cements, mortars, concrete and reinforced concrete; he must know what has been done and is being done in actual construction in the several lines of his profession. And that he may be fitted to eventually direct large undertakings, he must be familiar with the principles of power development and transmission in all its modern forms.

The work of the civil engineer of to-day consists largely in the design, construction and maintenance of fixed structures. Streets, bridges, water supply systems, sewers, conduits, subways, elevated tramways, docks and wharfs in our cities; embankments, deep cuts, bridging, tunnels and

terminals for the railroad systems; dams, reservoirs, canals, penstocks, powerhouses for the great hydraulic developments, and for the reclaiming of the arid lands; ship canals, locks and dry docks for shipping; steel frames, foundations for the modern skyscraper; these are some of the subjects which occupy the attention of the civil engineer to-day.

The magnitude of these works, their cost, and the rapidity with which they must be designed and built, have enormously increased in the past thirty years. A more exact knowledge of the properties of all kinds of structural material and of the laws which govern the forces of nature, with which the engineer must work, are demanded for the economical treatment of these large projects. The percentage of error and the factor of ignorance must be reduced to the lowest terms.

In physics many important discoveries have been made. Prominent among them has been the establishment of the theory that light consists of electric and magnetic vibrations.

The discovery of electromagnetic waves which led to the invention of wireless telegraphy, by which means within a few weeks a message has been sent across the ocean.

Discoveries regarding the connection between the all-pervading ether and matter.

The discovery of the peculiarities of the discharge of electricity through gases which led to the discovery of X-rays.

The liquefaction of air and gases which led to discoveries regarding the properties of bodies at very low temperatures.

The discovery of radium and other radioactive bodies and the investigation of their properties which has produced profound changes in our views regarding the construction of matter.

Discoveries of the process of conduction of electricity through gases, liquids and solids.

Developments in electrical engineering have been almost spectacular in their number and importance, revolutionizing, as they have, means of transportation and for the transmission of speech and power, and for lighting.

The telephone in 1876. The incandescent lamp in 1879. The commercial development of dynamo machinery and electric motors. The commercial application of electricity to street railway work, which had its beginning less than twenty years ago. The transmission of power over great distances made possible by the development of the alternating current transformer. A catalogue of discoveries and inventions in this field is not necessary, as one sees them on every hand. It may be truthfully said that the department of electrical engineering has been created within a comparatively few years. It was not until 1896 that our department of electrical engineering was separated from the department of physics within which it had its beginning. Now it is one of our great departments, attracting large numbers of students.

In 1868 the demand for trained chemists in this country was very small. At that time even the iron and steel industries did not perceive the advantage of controlling their various processes by careful and accurate analyses.

Andrew Carnegie was the first steel manufacturer who saw the importance of having trained chemists in his works, and in a short address made several years ago he said that one important cause contributing largely to his success was this fact. Such being the case, there was, at the time the institute was opened, little inducement for students to take up the subject of chemistry with the idea of following it as a profession, and though in the first catalogue issued the courses of study announced were mechanical engineering, civil engineering

and chemistry, the only difference in the work of the mechanical engineering department and the chemical department was that the time devoted to shop practise by students in mechanical engineering was spent in the chemical laboratory by those who had taken up the chemical course, and the time in the chemical laboratory was devoted entirely to analytical work. Such important subjects as organic chemistry, industrial chemistry and physical chemistry received no attention. All the work of the department was done in one room, which was also used for the little laboratory work that was given to the students in other courses.

As an illustration of the slight demand there was for chemists, the catalogues show that in the first six classes that graduated from the institute there is only one graduate who followed in after years the profession of chemistry.

Starting in 1868 with only one instructor in chemistry, and only one room for the laboratory, the department of chemistry, at the present time, 1906, has six instructors and separate laboratories for general chemistry, analytical chemistry, organic chemistry, industrial chemistry, sanitary chemistry and biological chemistry.

The work of the department has increased in a like manner. Where in 1868 instruction was only given in two main subjects, general and analytical chemistry, instruction is now given in fourteen different branches of chemistry. The cause of this increase, besides the increase demanded by the growth of the institute, is due to the difference in the positions now opened to chemists. In the early years of the institute the position offered to the graduate from the chemical department were practically that of the analyst, one who could make an examination of iron and steel. No knowledge of organic chemistry, or physical chemistry, or industrial chemistry, or sanitary chemistry was expected and electrochemistry was an unknown science. If the graduate from the chemical department could make a chemical analysis, that was all that was demanded or desired. Today, this is very different, for the positions offered to chemists require at least a fundamental knowledge of the various branches of chemistry, and one who is only fitted for an analyst has very little prospect of ever rising to any prominent or satisfactory position. This is due to the fact that there is hardly a large manufacturing company that does not now require a chemist, not merely to make analyses, but for the study and the improvement of processes.

Sanitary science in all its branches, agricultural chemistry and electrochemistry all demand chemists, and in every one of these branches will be found men trained in chemistry at the institute.

America is also beginning to follow the German plan, namely, to have connected with the most important manufacturing processes a research laboratory where chemists are employed in strictly research work, not with the work that is being done day by day in the factory, but on problems that, starting from theoretical ideas, may be tested to prove their commercial worth.

An interesting statement in a recent address by James M. Dodge, then president of the American Society of Mechanical Engineers, which is confirmed by the experience of our own graduates, reveals the fact that the average annual salary of the technical trained man is over $2,150, and for the nontechnical, but trade trained man, $790, so that the gain in average annual income due to a technical training is over $1,360. This amount capitalized at 4 per cent. gives to a man receiving a technical training a potential increase in value of $34,000. There are over one thousand liv-

ing graduates of the institute, to make no mention of an equal number who have spent more or less time at the institute, but who have not taken a degree, so that at the lowest computation the work of the institute since its incorporation, if measured in dollars and cents alone, would represent a capitalization of over $34,000,000. This represents merely a capitalization of the increased earning power of our graduates and takes no account of the enterprises which they have developed and which they direct, which would easily make the pecuniary measure of the contribution of our graduates to the world's assets a sum not less than $50,000,000.

Let us see if on this basis the state, the county and the city have not been great gainers by reason of the work of this institution.

The commonwealth from the earliest time has aided the cause of education, but has now withdrawn pecuniary aid from all the higher institutions of learning excepting from the three schools within her borders which are occupied with the problem of technical education, namely, the Massachusetts Institute of Technology, the Agricultural College at Amherst and the Polytechnic Institute at Worcester. To this school the commonwealth has given the sum of $200,000 in cash and makes an annual payment of $10,000 in consideration of which the institute educates 40 students who pay no tuition, at an expense to the institute of over $12,000 annually. But this by no means measures the benefit conferred by the school upon the state.

There are now engaged in active life in this commonwealth 397 of our graduates which represents directly and indirectly a wealth-creating power represented by a capitalization of approximately $20,000,000, against which may be set the $225,000 which has been received from the commonwealth during the period, making the balance against the commonwealth a considerable one. There are now engaged in active life in this county 214 of our graduates who represent directly and indirectly a wealth-creating power represented by a capitalization of $10,000,000. Certainly Mr. Boynton's gift of $100,000 for the benefit of the youth of Worcester County has borne fruit at least an hundred fold. There are now engaged in active life in the city of Worcester 173 of our graduates, representing upon the basis we have adopted a capitalization of $8,750,000.

Including the recent gift and bequest of Mr. Salisbury, the value of all our property, real and personal, is in round numbers $1,300,000, of which $1,000,000 has been contributed by citizens of Worcester. What a rich return upon the investment!

In addition to this, the institute, at an annual expense of about $300 per student, is educating at the present time over 100 Worcester boys a year, for which is paid the regular tuition of $160 per year, which equals but little more than one half of the cost, so that the institute is contributing to the youth of the city educational advantages which cost it $15,000 annually. Is there not abundant reason for the belief that when the need arises the citizens of Worcester will contribute generously to the funds of the institute?

Worcester is peculiarly dependent upon the brains of her people for her prosperity, much of which is due to our technically trained men who are directing the industrial affairs of the city, and upon whom the city must largely depend for future prosperity. Such in brief is the debt of the state, the county and the city to the school.

Since its organization something over two thousand students have been members of the institute. Eliminating from consideration all who did not graduate, the cost

to the institute of educating the 1,095 students who graduated has been $1,037,834, and there has been received from these students in the form of tuition fees the sum of $273,483. In other words the cost of education of the graduates has exceeded by $764,351 the amount received from them. In this computation no account is taken of the investment in plant and equipment which would increase the amount by about $400,000. In good time, I doubt not, the alumni who are able to do so will be glad to treat this as an obligation which they will take pleasure in discharging, though the facts are not mentioned here for the purpose of unduly emphasizing what might perhaps be regarded as a disquieting suggestion.

The application of science to the useful arts has had a controlling influence upon the political as well as the economic history of the world.

In 1814 Mr. Calhoun favored double duties as a protective measure. Mr. Webster, then senator from Massachusetts, opposed this policy. How strange his words sound to-day:

> I am not in haste to see Sheffields and Birminghams in America. I am not anxious to accelerate the approach of the period when the great mass of American labor shall not find its employment in the field.

In 1828, when a large investment had been made in manufacturing industries in Massachusetts, Mr. Webster had changed his position and favored the tariff. But the tariff was resisted by South Carolina, and the legislature of that state put forth the famous 'exposition and protest' containing Mr. Calhoun's doctrine of nullification. Thus was the position of these great men entirely reversed upon the question of the tariff. The explanation is very simple.

In 1791 our cotton was all imported, and the south wanted a duty to encourage its domestic production. The invention of the cotton gin by Eli Whitney, in 1793, a Worcester County boy, already referred to, which made it easy to separate the green cotton seed from the staple, revolutionized the cotton industry and made the south independent of the tariff. The invention of the cotton gin compelled the enunciation of the doctrine of nullification. The doctrine of nullification compelled the civil war.

Knowledge of engineering makes possible such great works as the building of the Suez Canal, which has revolutionized the trade relations between Europe and the east; the building of the great dam at Assouan to store the surplus water of the Nile; the construction now fairly beginning of the Panama Canal.

Another striking illustration is found in the policy adopted by the national government in the act of Congress of June 17, 1902, appropriating the receipts from the sale and disposal of public lands in certain states and territories to the construction of irrigation works for the reclamation of arid lands which cover about two fifths of the area of the United States. This fund now amounts to about $30,000,000, and projects under consideration in fourteen states contemplate the irrigation of 1,441,000 acres of land at an average cost of $25 per acre. A single example may be found in the work now under way in Wyoming in the portion of the Big Horn basin on the north side of the Shoshone River seventy-five miles east of Yellowstone Park.

This involves the construction of a dam seventy-five feet wide at the bottom of the channel and 200 feet wide at an elevation of 240 feet, the proposed height of the dam above the river bed, and the building of a spill-way connecting with a tunnel through the solid granite of the mountain. The canyon is so narrow that it is regarded as feasible to enclose the entire area covered

by the dam so that the enclosure may be heated and the work carried on during the winter. It is anticipated that 175,000 acres of land will thus be reclaimed, and that a population of 50,000 people will be added to a community now thinly settled. This great work, primarily of the civil engineer, is contributed to by almost all departments of applied science. Suitable foundations for the dam must first be found. The mechanical engineer explores with his drills; the geologist and the chemist determine the character of soil and rock; the civil engineer plans and constructs; the electrical engineer takes power developed from storage reservoirs and transmits it electrically to pumping areas and installs a telephone service so that the system may be safely and efficiently administered.

The once naked savage, who, perhaps, almost dying of hunger and thirst, feebly directed his tottering steps over these lonely and unfruitful regions, now at daily wages, which ensure him every comfort, participates as a citizen of the United States in this beneficent undertaking. In place of desolation will be found a large and intelligent population busily engaged in agricultural pursuits and all the attendant industries, while the church, the school, the college—companions of the highest type of civilization—create and minister to the noblest aspirations of a prosperous community. Thus does applied science contribute to the advancement of mankind.

One most potent influence in our industrial development has been our system of patent law. The patent office was created by the act of 1836. Up to January, 1861, 31,000 patents had been issued. Up to January, 1906, something more than 800,000. Under the stimulus of these laws the inventive faculty of our people has exceeded that of any other country. In the administration of these laws within the patent office and in the practise under them without, there are now engaged more than thirty of our own graduates who are peculiarly fitted because of their training to succeed in this important field.

The industrial development of the world has been stimulated by the great expositions which have been held from time to time in different countries. That of England in 1851; at New York in 1853; at Paris in 1855; again in England in 1862; in Paris in 1867, greatest of all up to that time; at Vienna in 1873; at Philadelphia in 1876; at Paris in 1878; at Chicago in 1893; and at St. Louis in 1904.

I have recently seen the statement that modern technical education is the direct result of the London exhibition of 1851, where for the first time was given an opportunity to see side by side the industrial products of all nations. However this may be, it is certainly true that the event was one of great importance to the industrial world.

In February, 1850, the first of the great public meetings on the subject was held in England. France, Prussia, America and Belgium were represented. Lord Morpeth, who presided at the meeting, in closing his speech, said:

> I can not better sum all that may be said than in words written nearly a century and a half ago. Listen, ladies and gentlemen, and see if Pope was not almost as good a prophet as he was a poet:
>
> The time shall come, when, free as seas or wind,
> Unbounded Thames shall flow for all mankind,
> Whole nations enter with each swelling tide
> And seas but join the regions they divide;
> Earth's distant ends our glories shall behold
> And the new world launch forth to seek the old.

The Prince Consort, to whom the chief credit is due for the inception and management of the great enterprise, made a speech at the Mansion House in March, 1850, in which he said of the purpose of the exhibition that it was to

give the world a true test, a living picture, of the point of individual development at which the whole of mankind has arrived, and a new starting point from which all nations will be able to direct their future exertions.

How well it served its purpose is demonstrated by the fact that at the exposition in Paris in 1867 England found that while in 1851 her supremacy had been undisputed, in 1867 out of 90 departments she had superiority in only 10. An investigation led to the conclusion that the cause of this was the better scientific instruction given to artisans on the Continent. France, Prussia, Austria, Belgium and Switzerland possessed good systems of industrial education for the masters and managers of factories and workshops, while England possessed none.

An Englishman, a judge in the class of woolen textile fabrics, said, speaking of the continental workmen:

Brains sit at the loom and intelligence stands at the spinning wheel.

At this exposition the progress of France and Germany was especially commented upon.

Sir Lyon Playfair, speaking some years ago of the influence of technical education upon the industrial prosperity of Switzerland, said:

The Coventry ribbon trade, which has deserted England, has settled in the valleys of Switzerland. The polytechnic institute has aided in this result, because it turns out seventy or more persons annually, trained in the science and art requisite to conduct such a manufacture successfully.

This single branch of manufacture so transferred from England to Switzerland employs in the latter thirty thousand weavers and other collateral workers, such as dyers and superintendents. The value of the annual export of this manufacture from Switzerland is eight million dollars, while the trade has languished at Coventry in England until the annual export is little more than three hundred thousand dollars.

"The difference," says Lord Lyon, between the Swiss trade and the Coventry trade, "is very simple; it is involved in the answer given by Opie, the painter, to a youth who asked him how he mixed his colors—'I mix them with my brains, sir.'"

It is a striking fact that England, which has produced Arkwright, Watt, Stephenson and Bessemer and others equally distinguished, should have been unable to keep pace with other nations in the application and development of the principles which these men first disclosed. It may be accounted for in some degree at least by another surprising fact, that in industrial education England is excelled by all the leading nations of the world.

There is undoubtedly a demand in this country at the present time for the education of those in our industries who need the skill of the mechanic and an order of intelligence superior to that of the ordinary workman. This has long been recognized and has been met in some slight degree both within and without this commonwealth. This need is more apparent than ever at the present time when the specialization of industries has reached a point where the old-fashioned all-around mechanic is becoming more and more difficult to find.

While there is no great dearth of engineers, there is a short supply of skilled workmen of intelligence. This is a department of industrial education that can not be safely neglected. Germany has appreciated this fact, and leads all the countries of the world in this as in all other departments of technical education, and owes to this, very largely, her present industrial position.

President Alderson, of the Colorado School of Mines, in a recent article, speaks as follows of present conditions:

There are six building and mechanical trade schools in New York and Brooklyn, three in Boston, two in San Francisco, and two in Philadelphia. New York has two brewing academies; Chicago and Milwaukee one each. Philadelphia, Lowell, New Bedford and Atlanta have textile

schools. Chicago, St. Louis, Omaha, Peoria, Waltham, Winona and LaPorte have watch making and engravers' schools. The universities of Wisconsin and Minnesota, and the Iowa College of Agriculture have schools of dairying. For dressmaking, millinery and the domestic arts and science, schools exist in Boston, New York, Brooklyn, St. Louis and Philadelphia. Eight cities contain schools to teach barbering. St. Louis has a school for railway telegraphers; Effingham, Illinois, a college of photography, and New York an academy for shipbuilders.

Still another extension of technical education is to be noticed in our large cities, where technical schools have opened their doors in the evening and have invited students, employed during the day, to enter and learn what they can. These night schools are exceedingly common in England, so common that they have undermined the influence of the regular day schools and have implanted the erroneous idea in the mind of the average young Englishman that he can work all day, go to school at night, and still be successful in each case. Such we know to be fallacious. The true conception of night school work is that it is only a means of securing essential facts, but is not education in its truest sense. The Germans have not made this mistake and emphasize the necessity of giving undivided attention either to educational work or to industrial work, but not to combine the two. Interesting in connection with evening instruction by technical schools is the use of local centers or technical clubs, with home-rule organization, but with the same end in view.

At the end of this list must be added the educational work of the Y. M. C. A., which quietly but effectually reaches thousands of students. All these influences combined reach an industrial army that can be counted in the millions. The movement for more technical education is certainly far-reaching and important.

He also expresses the opinion that at one time or another not less than two million in the United States have taken one or more courses in some correspondence school. The industrial training given at Tuskegee is another indication of the great value placed upon it as an essential part of education and possesses additional interest and importance from the fact that it is regarded as the most efficient manner in which to permanently improve the condition of the negro in the south.

In our own state, the Lowell Textile School opened in October, 1897; that in New Bedford in October, 1899, and that in Fall River in 1900. These, in Massachusetts, are trade schools of a pure type, and serving a most useful purpose, supported in part by the commonwealth in the interests of the textile industries which from the earliest times have been so important to our people.

This need was recognized by the advisory committee invited by the trustees of the Carnegie gift to present a plan for the technical school to be established at Pittsburg. They recommended the establishment of the (1) Carnegie Technical College; (2) Carnegie Technical High School, where is to be taught engineering principles, steam engine practise, pattern making, tool making, etc.; (3) Carnegie day and evening classes for artisans. The two latter recommendations attempt to provide for the need of which I have spoken. This plan seems to be modeled upon that of Norway, proposed in 1868, involving Sunday and evening schools for mechanics, elementary technical schools of a practical character and a polytechnic institute of the highest grade.

The subject of industrial and technical education in this commonwealth has been recently considered in the report of a committee appointed under the authority of the legislature of which our accomplished fellow townsman, Dr. Carroll D. Wright, president of Clark College, is the chairman. His attainments in industrial economics make this report of authoritative value. In it the need in this country is recognized of more skilled workmen, of those possessing not so much manual dexterity as 'industrial intelligence,' by which is meant—and I now quote from the report—

Mental power to see beyond the task which occupies the hands for the moment to the operations which have preceded and to those which will follow it—power to take in the whole process, knowledge of materials, ideas of cost, ideas of organization, business sense, and a conscience which recognizes obligations.

This need the committee believes should be met by industrial education in the public schools and through independent industrial schools; such instruction is, of course, designed for students younger than those with whom we have to deal here, and is of an entirely different grade and character, but, nevertheless, is of very great importance. In this report the Massachusetts Institute and the Worcester Polytechnic are spoken of as institutions which train mechanical and electrical engineers, manufacturing chemists and architects—men in the highest ranks of productive industrial life; institutions which have fully justified all that they have cost and of world-wide fame.

If I may borrow further from this interesting report, I will add that the system of industrial and technical education in the German empire is held up as an example, and a comparison is made which shows that if Massachusetts were to maintain a system of industrial schools of proportionate development with that of the kingdom of Prussia, we should need three hundred such schools with a total enrollment of twenty thousand.

It would be idle to assert that the industrial supremacy of the United States is due primarily to our system of industrial education, because, as a matter of fact, we are inferior in this respect at least to Germany, France and Switzerland. But the time is certainly fast approaching when we must take heed of the industrial competition from other countries which are adopting our machinery and methods, stimulated by what they learn at the great expositions. It is certain that without great effort we can not retain our supremacy undisputed; and for this reason it behooves us to pay particular attention to the industrial education of our people.

Just as in agriculture, after the virgin soil begins to be exhausted by wasteful methods of cultivation, scientific methods must be employed if the quantity and quality of crops are to be maintained; so in other industrial pursuits—as competition forces prices down, the labor must be more intelligent, the scientific knowledge more exact, if satisfactory results are to be secured.

It is a mistake to think, as is often said in this country, that the 'pauper labor' of Europe is a menace to us. It is rather the educated labor of European competitors of which we should stand in fear.

I believe it to be true to-day that in a large number of our industries in which labor-saving machinery is used to any considerable extent, the cost of labor per unit is less than in any country in the world, and for the reason that our labor is so much more efficient.

As men with a technical education are the ones who will manage our railways and great manufacturing plants, they naturally have a deep interest in, and should have an intelligent knowledge of, the changing conditions under which business is being done, information which our own students acquire in the department of political science.

The factory system was a product of the close of the eighteenth century—the trust, so-called, of the close of the nineteenth; and great abuses have attended each change, which are quite independent and separable from the system which they accompanied.

The great cruelties attendant upon the labor of women and children were a blot upon the former. These have happily largely disappeared before the corrective

of intelligent legislation—and the same remedy will no doubt be efficiently applied in due time to the evils attendant upon the latter, to which the attention of the whole country is now directed.

To consolidation as such, I think there can be no rational objection, and I will hazard the opinion that competent young men who are obliged to stand absolutely on their own merits have a better chance to succeed to-day than ever before in the history of the country. The time at my command—already, I fear, exhausted, as well as your patience—does not admit here of any extended discussion of this interesting question.

The 'good old times' were not as good as these, and I believe that these are not as good as those that are to come. Macaulay, who so richly embellishes every subject he touches, uses the following illustration:

> In truth, we are under a deception similar to that which misleads the traveler in the Arabian desert. Beneath the caravan all is dry and bare; but far in advance and far in the rear is the semblance of refreshing waters. The pilgrims hasten forward, and find nothing but sand where, an hour before, they had seen a lake; they turn their eyes, and see a lake where, an hour before, they were toiling through sand. A similar illusion seems to haunt nations through every stage of the long progress from poverty and barbarism to the highest degrees of opulence and civilization. But, if we resolutely chase the mirage backward, we shall find it recede before us into the regions of fabulous antiquity.

At no time has the question of the rights of the people, as against those of the so-called vested interests, been as prominent, I may say as all-absorbing, as at this moment. Forty years ago the government was encouraging the building of railroads by enormous grants of land. The chief desire of the nation and the states was to get the means of transportation at any cost. The recent session of Congress has been largely devoted to devising means for regulating railroad rates—already at a lower point than any one twenty years ago would have dared to predict. I have no quarrel with this wholesome legislation. I merely use the incident as an illustration. This is the day of the reasonable control of business and of the elimination of abuses which have inevitably sprung up alongside and been dwarfed by an industrial development more rapid and more stupendous than any that the world has ever seen. In this important work, educated men and, above all, technically educated men, should take the lead, if it is to be well done, and done it will be. The conscience of the country has been quickened as never before, largely, I believe, through the initiative of the president of the United States, who only needs to see a wrong to exert all the prerogatives of his great office to remedy it.

Happy that land where the people govern; where education is not for the cloistered few but within the reach of every child; where the limits to ambition are only those prescribed by the ability and disposition of the individual, and which advances from generation to generation to better and better things.

Charles G. Washburn.

SCIENTIFIC BOOKS.

The Biology of the Frog. By Samuel J. Holmes, Ph.D., Assistant Professor of Zoology in the University of Wisconsin. New York, The Macmillan Co. 1906. $1.60 net.

A most useful addition to our text-books on the frog. It presents not only the anatomy and embryology but also the physiology and natural history of the frog; so that for the first time a single book covering the whole ground of the biology of the frog is accessible to teacher and student.

The text of 358 pages is divided into nineteen chapters. The first places the particular kind of frog (the leopard frog, *Rana pipiens*), which is the chief subject of the volume, in proper relation to other kinds of frogs and to the salamanders by a brief consideration of

the classification of the amphibia with special reference to the common American forms and their habits. The second is one of the most interesting of all and considers in some three dozen pages the life and habits of this common frog; recounting its methods of locomotion and of feeding; describing its voice, enemies, parasites, as well as its breeding habits and its responses to changes in temperature, etc.

The succeeding two chapters briefly describe the exterior of the frog and the main features of its internal structure, reserving for later chapters detailed descriptions of anatomy and physiology. The fifth chapter devotes some 38 pages to the embryology of the frog from the time the egg is laid through the metamorphosis into the adult shape, and includes a brief historical introduction. Chapter six presents a brief outline of vertebrate histology as illustrated in the frog, while chapter seven takes up the digestive organs rather fully, with special emphasis upon glandular activity. The eighth chapter deals with organs of voice and of respiration from a physiological standpoint and leads to the ninth chapter, which is devoted entirely to the skin, an undue amount of space being devoted to its color changes.

The excretory organs and the reproductive organs each receive a chapter descriptive of their anatomy and functions.

The devotion of an entire chapter to the subject of internal secretions is timely and the restriction of the treatment of the skeleton to a single chapter of fifteen pages shows commendable restraint, considering the large amount of detail that might so readily have been retained here.

From the point of view of the student the ten pages devoted to the muscles might well have been made fewer.

The fifteenth chapter describes the microscopic structure of the blood, the anatomy and action of the heart, the distribution of the veins and arteries and the circulation as seen in the web of the foot, with also a brief consideration of the lymph system.

The sixteenth chapter gives a good description of the anatomy of the nervous system and considers reflex actions and the conflicting evidence as to the functions of the various parts of the brain: so that 35 pages are needed.

The structure and uses of the sense organs are adequately treated of in some 20 pages.

The last two chapters deal with the instincts, tropisms and intelligence of the frog as known from the works of Yerkes, Parker and others. Probably the presentation given will give the student a just conception of the rather confused and tentative nature of the results thus far gained by the experimental study of the psychology of the frog.

The author has prepared the book as the outcome of six years of lectures given to students who had studied some general biology. As a compilation it gives the gist of the anatomy and histology of Gaupp's 'Ecker,' and enough of the embryology of Marshall and deserves great praise for bringing together in attractive form much of the scattered knowledge of the natural history and physiology of the frog. To be commended is the list of authors at the end of each chapter and the impression conveyed that the conclusions reached in the physiology and psychology of the frog are complex balancings of diverse facts and opinions while suspended judgment is often imperative.

The 94 illustrations are, with few exceptions, the familiar figures of Ecker, Howe and Marshall and while one need not expect many illustrations for a physiological presentation of the subject yet one could wish that the excellent photographs used as a frontispiece might have been followed by others illustrating the natural history of the frog.

While the book is easily read and the author's meaning clear, some hypothetical student punctilious as to English but ignorant of natural history, might be misled in reading of the feeding habits of the toad, page 14: 'angleworms are seized by the jaws and stuffed into the mouth by the fore legs.'

Every teacher of vertebrate zoology will need a copy of the book and many college students will find it a valuable text-book. But while the central idea of adding physiology and natural history to anatomy and embryology is a good one, it almost necessarily leads to putting too much knowledge before the student. In a second edition, for which we

hope there soon may be demand, the author might perhaps better satisfy a larger number of students by a thoroughly digested epitome of the present book, while the teacher should welcome another volume that would still further elaborate all but the anatomical part of the present book. For the teacher there might be added a consideration of the geographical distribution of frogs, with maps; a full discussion of the remarkable breeding and brooding habits of some exotic frogs; more ample reference to the field of regeneration in frogs; an account of the genesis of the egg and the sperm; and original illustrations. He would then have a fit complementary volume to Gaupp's 'Ecker.' E. A. A.

Easy Mathematics, chiefly arithmetic; being a collection of hints to teachers, parents, self-taught students and adults, and containing most things in elementary mathematics useful to be known. By Sir Oliver Lodge, F.R.S. Macmillan and Co. 1905. Pp. xv + 436.

When a man like Sir Oliver Lodge writes on arithmetic we naturally expect an unusually high motive. In the present case this motive is set forth in such forceful terms as follow:

> The mathematical ignorance of the average educated person has always been complete and shameless, and recently I have become so impressed with the unedifying character of much of the arithmetical teaching to which ordinary children are liable to be exposed that I have ceased to wonder at the widespread ignorance, and have felt impelled to try and take some steps towards supplying a remedy. The object in writing the book has been solely the earnest hope that the teaching of this subject may improve and may become lively and interesting. Dulness and bad teaching are synonymous terms. A few children are born mentally deficient, but a number are gradually made so by the efforts made to train their growing faculties.

To read an arithmetic written in a breezy style yet thoroughly sane from cover to cover is a surprisingly interesting experience for most people who try it. While those who are familiar with elementary mathematics may not learn any new facts by reading this book, yet there will probably be few who will not have a more cordial attitude towards the subject. It works a change of feeling and clearness of vision rather than a deeper insight into the more abstruse parts.

The charm of many illustrations lies in their extreme simplicity. For instance:

> It is very often a mistake for teachers to suppose that some things are easy and other things are hard; it all depends on the way they are presented and on the stage at which they are introduced. To ascend to the first floor of a house is difficult if no staircase is provided, but with a proper staircase it only needs a little patience to ascend to the roof. The same sort of steps are met with all the way, only there are more of them. To people who live habitually on the third floor it is indeed sometimes easier to go on the roof than to descend into the basement. Educators should see that they do not forcibly drive children in shoals up an unfinished or ill-made stairway, which only the athletic ones can climb.[1]

The first part of the volume is partly historical. In some of this the imagination is explicitly allowed to wander beyond the established facts. In addition to most of the questions which are met in arithmetic and elementary algebra, there are chapters on *Easy Mode of Treating Problems that require a Little Thought, dealing with Very Large or Very Small Numbers; Pumps and Leaks, Differentiation, etc.* The work is divided into forty-seven brief chapters and throughout impresses one with the fact that the greatness of a man is perhaps most strikingly exhibited by his treatment of common subjects. The author with a narrow outlook would not make such a wise choice of subject matter and would not be apt to refresh the reader with such broad views as 'Real living arithmetic is the same in any country; and most important of all is that which must necessarily be the same on any planet,' and 'An equation is the most serious and important thing in mathematics.'

While the book naturally appeals most strongly to the teacher, yet it seems to be eminently suitable for those who desire to get a clear view of the subject matter which has been employed in their early training. The sub-title has a quaint eighteenth century flavor, but the book itself is thoroughly modern

[1] Page 13.

and may be regarded as one of the best expressions of the spirit of the recent reform movement in mathematical instruction.

G. A. MILLER.
STANFORD UNIVERSITY, CALIFORNIA.

SOCIETIES AND ACADEMIES.

THE ST. LOUIS CHEMICAL SOCIETY.

AT the regular meeting of the society on Monday, June 11, Mr. W. R. Lamar presented a paper entitled 'Recent Investigations on the Constitution of Certain Alkaloids.' After a few preliminary remarks on the difficulties encountered in determining the molecular constitution of these substances and on the methods employed for the purpose, the paper was devoted to four substances: namely, conine, nicotine, atropine and cocaine. The society was treated to an exceedingly comprehensive and condensed account of the investigations into the constitution of each of these bodies, indicating the failures as well as the partial and complete successes. This was followed in the case of each substance by a similar account of the efforts at producing the same substances synthetically.

C. J. BORGMEYER,
Corresponding Secretary.

DISCUSSION AND CORRESPONDENCE.

THE HAILSTORM OF JUNE 23.

TO THE EDITOR OF SCIENCE: During the storm which swept the Atlantic coast on Saturday, June 23, the hailstones which fell at Perth Amboy, N. J., and vicinity were of such large size that the following observations from a house on the shore of Raritan Bay may be worth recording. The hailstorm was preceded by the piling up of great masses of cumulus clouds, while out in the Lower Bay a tornado caused a waterspout; there was also considerable lightning and a brief heavy shower of rain, so that the usual conditions for a severe hailstorm were satisfied. About four o'clock big hailstones began to bombard the house, at first few in number and in a very slanting direction, then in a roaring downpour that made the bay spout up into thousands of white geysers. This lasted, perhaps, five minutes.

We immediately gathered some of the hailstones which thickly dotted the lawn. They ranged from the size of a cherry to that of a duck's egg, the larger ones being very abundant. The smaller ones were more or less spherical, consisting internally of broad concentric zones of softer, more snow-like, and of harder, darker ice, the broken surfaces reminding one of polished sections of concretionary nodules of agate. The larger ones were oblate spheroids, oval in contour, with crater-like depressions in the center of each flattened side. The largest ones filled the palm of the hand, and upon being measured with great care proved to be not less than three and one eighth inches along the long diameter and eight inches in circumference. The surface was irregularly tuberculated, and the center, core or axis of the spheroid was always distinct, appearing in broken hailstones as a small white spot. None were observed in which the nuclei were formed of small pebbles. The hailstones seemed harder to crack in the teeth than ordinary ice.

The impact of their fall caused circular depressions in the hard-packed tennis court, and later on the soft sand of the beach the still unmelted kernel of each hailstone was found in a depression containing a close coil or many concentric circles of sand.

Mr. George H. Pepper, of the American Museum of Natural History, who also observed the same storm in Tottenville, at the southern end of Staten Island, appends the following notes:

The first evidence of the storm in Tottenville was a heavy rain accompanied by a shower of small hailstones about the size of a pea; these stones were similar to snow ice. The rain continued and after an interval of perhaps five minutes a second shower of hailstones was noticed; these ranged from the size of hickory nuts to walnuts. The fall of these stones was followed by the larger ones, the intervals being, perhaps, two or three minutes. The shower carrying the large hailstones lasted not more than three minutes, but during that time twenty-five glasses were broken in the house in which I happened to be. Over fifty glasses in memorial windows

of one of the churches were broken, and almost every house having windows on the western side suffered from the stones. One of the largest stones was measured, the result showing a circumference of nine inches; it was irregular in form, one and a half inch thick and the edge was deeply indented in places. This was not an exceptional stone, as a great many of this size were found.

W. K. Gregory.

American Museum of Natural History.

SAUROPODAN GASTROLITHS.

To the Editor of Science: It may be of interest, in connection with Mr. G. R. Wieland's recent description of the gastroliths found with the sauropod remains in Montana, to call attention to an apparently unrecorded similar discovery at Morrison, Colo. In 1877, Professor O. C. Marsh's party, in charge of Professor Arthur Lakes, obtained among the bones of the type specimen of *Atlantosaurus immanis* Marsh, a number of rounded and highly polished siliceous pebbles whose surface peculiarities resembled those of the gastroliths described by Mr. Wieland. No material of similar size, form, surface markings or composition occurs elsewhere in the Atlantosaurus clays of this vicinity. Professors B. F. Mudge and S. W. Williston were with us when some of these pebbles were found and considered them as identical in origin with the stomach stones that they had recently found with plesiosaurian remains on the plains of Kansas. With the exception of one specimen, now in the collection of fossils in the Denver High School, these specimens were probably sent to the Peabody Museum of the Yale University and might be found in the collections sent to Professor Marsh by Professors Lakes and Mudge from the neighborhood of Morrison during the years 1877 and 1878. The field notes of Messrs. Lakes, Mudge and Williston, if obtainable, might afford additional data and possibly confirm a suspicion of the writer that some gastroliths were also found in connection with the type specimen of the species formerly known as *Apatosaurus ajax* Marsh.

Geo. L. Cannon.

Denver, Colo.

THE SMITHSONIAN INSTITUTION AN INSTITUTE OF RESEARCH.

To the Editor of Science: I desire to emphasize the suggestion made by David Fairchild in Science for June 8, in which he advocates changing the Smithsonian Institution from a museum to an institute of research. It seems to me that this idea ought to appeal strongly to men of science generally throughout the country. It can not be denied that the greatest impetus to research in pure science in the past has been the working together of men earnestly engaged in special lines of research, and the value of such researches has been greater whenever the several investigators have been brought together in one institution or in one laboratory. Experience has shown that under such conditions only as are found, for example, in the Biological Station at Naples, or in the laboratories of the greater German universities, does the most stimulating atmosphere of research exist.

The elaborate and well-endowed scientific projects now in operation, although extremely valuable, can not do for the progress of knowledge what such institutions as the above mentioned are doing. We have in this country large and well-endowed museums that are amply able to care for the work that falls within their respective provinces, but there is no institution that can be looked upon as a common center of research to which the investigator may go to pursue his studies with the necessary equipment and in an atmosphere whose vigor comes from the helpful suggestions and from the keen but friendly criticism of his many colleagues.

Let the Smithsonian Institution, therefore, be the nucleus of such a great national or international institute of research.

David M. Mottier.

Indiana University.

SPECIAL ARTICLES.

EVIDENCES OF GLACIATION IN SOUTHERN ARIZONA AND NORTHERN SONORA.

In the spring of 1905, during a professional trip to Sonora the writer was interested in observing along the Sonora Railway, south of

Nogales, frequent exposures of material resembling in every way, except in its component rocks, that of the terminal moraine of New York and New Jersey. These exposures were between Nogales and Imuris, occurring frequently in a distance of some fifty miles, and exhibited sections of till and boulder clay with large angular rock fragments and the occasional partial stratification characteristic of various portions of the terminal moraine in the northeast.

Having then no opportunity to verify these observations, they were briefly noted, to be amplified on some future occasion.

During the months of April and May of the present year, a further opportunity was afforded to traverse the same country and secure additional data bearing on the phenomena mentioned.

These last observations have convinced me that there is, in the vicinity of Nogales, both in Arizona and in Sonora, and for a number of miles north and south of the national boundary, an area of some width in which land ice transportation has been operative and has resulted in the formation of morainal deposits of various types.

A complete absence of detailed maps in northern Sonora makes it difficult, without extended study in the field, to form any generalizations concerning the centers of accumulation from which the glacier or glaciers may have flowed.

In Arizona, the publication, during 1905, of the Nogales, Patagonia and Tucson quadrangles affords an opportunity to locate the more important phenomena observed and determine the possible sources of ice action.

Some ten miles north of Nogales rises from the general level of the surrounding desert country a high range known as the Santa Rita Mountains. At the desert level, which is about 2,700 feet, this range has a base approximately thirty miles long and from eight to fifteen miles wide. Its highest peak has an altitude of 9,400 feet and a considerable area of the range (perhaps twenty square miles) is above the six-thousand-foot level. Within a mile or two of the southeastern base of the range passes the Sonora Railway, which, here as in Sonora, by its numerous cuts and borrow pits, gives an opportunity to study the composition of a formation which has all the characteristics of a moraine deposit, but which, in the absence of sections, a casual observer might pass by as a terrane of volcanic material rotted in place.

In connection with the structure exposed by the sections, one recognizes at many points the rolling topography and pitted surface of a moraine. At one or two points are observed depressions, similar to those which in the north have been formed by stagnant ice, surrounded by kame terraces and their concordant phenomena. One of these is just south of Huachuca Station.

About three miles south of Nogales is a very extensive borrow pit, formed in the construction of the railroad, in which has been left a number of large rock fragments which are clearly of transported material. Among these, the writer noted several blocks of dark blue limestone which did not belong to the crystalline terrane beneath and which had evidently been transported some distance.

A marked difference between the transported material here and that in the north lies in the comparative absence of large boulders, for none were seen to exceed about two feet in diameter. This is probably due to the character of the volcanic rocks and their manner of decay. A cliff of andesite or rhyolite does not in Arizona or Sonora seem to yield talus fragments of as large size as a cliff of granite or gneiss in New York.

The total extent of these glacial formations could not be determined without an extended reconnoissance which the writer had not time to make, but they are apparently limited to the vicinity of the higher mountain ranges. About twenty miles west of the Santa Rita Mountains, between Sopori and Arivaca, on the west of the Atascosa Range, is a long stretch of low hills and rolling country, trending southwesterly, which has a morainal appearance; but in the absence of sections no decisive conclusion was reached.

In northern Sonora, near the valley occu-

pied by the railroad and between Nogales and Imuris, one sees near the mountain bases low benches which have been eroded into overlapping oblique ridges of which the material seems to be all of morainal character. These overlapping ridges form prominent features in the landscape and are locally called by the Mexicans *cordones,* or 'chains.' They have not been observed by the writer south of Magdalena.

In traveling eastward from Benson toward El Paso, at a few points, mountain masses were observed, rising from the desert plains, around the bases of which were slightly elevated benches corresponding in some measure to the bench of morainal material along the eastern base of the Santa Rita Mountains. Occasionally, also, the railroad cut through low rolling ridges of material, morainal in structure and clearly not formed by sheet flood erosion.

On the Rock Island Railway, about a mile southwest of Santa Rosa, N. M., near the southeastern bank of the Pecos River, is a train of rolling hills which show morainal structure in the railroad cuts.

These observations lead to the conclusion that the quaternary history of some portion of this region is more complex than has been supposed. Clearly before the present period of arid climate and periodic sheet flood erosion was a time of low temperature and accumulated precipitation in the form of land ice which resulted in the formation of extensive deposits of rock debris around the bases of at least the higher mountain ranges. Climatic conditions limited the extent of these moraines so that the present desert basin areas, in many cases, remained unglaciated.

A further point of interest is the hypothesis, suggested by the facts observed, that some of the quaternary conglomerates which are abundant in northern Sonora and are so puzzling in respect to their origin may in part be the result of glaciation. The writer has, so far, been unable to formulate any other theory of origin which will account for the presence, in some of these beds, of boulders as large as two feet in diameter, in a matrix of angular fragments, of many different kinds, mingled with fine material. In a bed of true volcanic breccia one does not ordinarily find several different kinds of eruptive rock varying greatly in composition.

Frederick J. H. Merrill.
New York City.

Zygospores and Sexual Strains in the Common Bread Mould, Rhizopus Nigricans.[1]

From the preliminary communication of J. I. Hamaker in the May 4 number of Science, entitled 'A Culture Medium for the Zygospores of *Mucor stolonifer*' (*Rhizopus nigricans*), one would be led to suppose that the method of obtaining the zygospores of this species by admixture of strains from different sources was unnecessarily troublesome and uncertain. After having obtained the zygospores frequently for three months, he is brought to the conclusion, which is printed in italics, that 'with proper conditions of moisture and temperature, success is apparently dependent only on the nature of the substratum.' As a favorable substratum, a corn muffin bread is recommended and a detailed formula of the ingredients is given.

In a preliminary summary of a study of the sexual conditions in the Mucorineæ,[2] the present writer has used this same common bread mould *Rhizopus nigricans,* as a type of the heterothallic (*i. e.,* dioecious) group in which each species is to be considered an aggregate of two distinct sexual strains the interaction of which is requisite to zygospore formation. In contrast to homothallic (*i. e.,* hermaphroditic) species in which the mycelia are sexually all equivalent and which may produce zygospores from the sowing of a single sporangiospore, it is necessary in the heterothallic species, in order to obtain the zygospores in pure cultures, to sow spores together from both the sexually opposite strains which have been provisionally designated by the terms

[1] This paper was written while working under a grant as research assistant to the Carnegie Institution.

[2] 'Zygospore Formation a Sexual Process,' Science, N. S., 19: 864–866. 1904.

(+) and (—). The rarity of the zygospores of heterothallic species therefore may be explained by assuming that when zygospores fail to form under conditions which of themselves are not unfavorable to zygospore formation, only one of the two sexual strains is present.

Ever since de Bary[3] discovered the zygospores of *Rhizopus* in 1865—now forty years ago—various and conflicting theories, based many of them upon the character of the substratum upon which the zygospores were accidentally found, have been brought forward to account for the rarity of their occurrence. The writer has attempted to show the insufficiency of the assumption that external conditions are of more than secondary importance, and has given at the same time a rather full account of cultural experiments with the strains of *Rhizopus*.[4] It is not the purpose of the present article to repeat the details there given. It seems not inappropriate on this occasion, however, to say a few words regarding the occurrence in nature of the strains of this species based upon recent investigations as well as upon those already published. For the sake of comparison, a list of those species the thallic condition of which has been determined, will be given arranged according to the type of their sexual reproduction, and something will be said concerning the cultivation of *Rhizopus* for class purposes.

In Table I. are listed the zygosporic cultures from which the sexual strains have been isolated by the writer. In making the separations, a large number of cultures were necessary as indicated in the table. Tests with both the standard (+) and (—) strains were not made for all the cultures listed, but no strains were found which alone in pure cultures could be brought to zygospore formation.

In the preparation of Table II., the individual strains obtained through the kindness of the writer's correspondents were tested in separate cultures against standard (+) and (—) strains. Each strain therefore listed as (+) or (—) produced zygospores in contrast with the test strain of opposite sign and failed to produce them in cultures with the test strain of the same sign. Those strains which would form zygospores with neither the (+) nor the (—) test strain on the substratum used were provisionally listed as neutral. Judging from the possibility of inducing temporary neutrality in the strains of *Mucor Mucedo* by cultivation under unfavorable temperatures, one might suppose the neutrality in these strains of *Rhizopus* to be likewise but a temporary condition. With their exception, all of the 43 individual strains tested are either (+) or (—). To the 11(+) and 19(—) strains in Table II., should be added the 8(+) and 8(—) strains isolated from the zygosporic cultures of Table I. We shall then have from the strains tested 19(+), 27(—) and 13 apparently neutral. Out of this total of 58 individual strains, none have been found which will yield zygospores when grown alone in pure cultures. As may be seen by a glance at the tables, strains have been collected from various parts of the world, and the conclusion seems irresistible that the common bread mould, *Rhizopus nigricans*, is heterothallic and that the interaction of the two sexually opposite strains is necessary to the formation of their zygospores.

TABLE I. STRAINS IN SPONTANEOUS ZYGOSPORIC CULTURES.

Source of Zygosporic Cultures.	Substratum on Which the Zygospores Were First Discovered.	Number of Pure Cultures Tested.	
		(—)	(+)
Boston, Mass.....	Shells of almond nuts on sterilized paste.	1	29
Brookline, Mass.....	Shells of almond nuts on sterilized paste.	2	6
Newton, Mass. (*a*)..	Shells of almond nuts on sterilized paste.	3	18
Newton, Mass. (*a*)..	Shells of almond nuts on sterilized paste.	1	1
Newton, Mass. (*b*)..	Shells of almond nuts on bread.	3	18
Cambridge, Mass....	Decayed potato.	1	6
Chapel Hill, S. C....	Bread.	6	6
Stanford Univ., Cal.	Squash.	5	2
Raleigh, N. C.....	Sweet potato.	19	1
8 zygosporic cultures	Totals, 107 strains.	38	69

[3] 'Beiträge zur Morphologie und Physiologie der Pilze,' II., 1866.

[4] 'Sexual Reproduction in Mucorineæ,' *Proc. Am. Acad.*, 40: 205–319, pls. 1–4. 1904.

TABLE II. INDIVIDUAL STRAINS ARRANGED ACCORDING TO SEXUAL CHARACTER.

(−)	Neutral.	(+)
Boston, Mass.	Brookline, Mass. (2)	Brookline, Mass.
Jamaica Plain, Mass. (2)	Winthrop, Mass.	Worcester, Mass.
New Haven, Conn.	Middletown, Conn.	New Haven, Conn.
Cazenovia, N. Y.	Granville, Ohio.	Storrs, Conn.
Chicago, Ills.	Breslau, Germany.	Washington, D. C.
Lansing, Mich. (2)	Leipzig, Germany.	Ithaca, N. Y.
Austin, Texas.	Halle, Germany.	Delaware, Ohio.
Columbia, South Carolina.	Honolulu, H. I.	Madison, Wisconsin.
Nassau, Bahamas.	Margarita, Venezuela. (2)	St. Louis, Mo.
Progreso, Yucatan.	Caracas, Venezuela.	Paris, France.
Cambridge, England.	Port au Prince, Haiti.	Berlin, Germany.
Paris, France.		
Nancy, France.		
Bern, Switzerland.		
Berlin, Germany.		
Eisenach, Germany.		
Manila, P. I.		

TABLE III. LIST OF SPECIES, THE THALLIC CONDITION OF WHICH HAS BEEN DETERMINED, ARRANGED ACCORDING TO THE TYPE OF THEIR SEXUAL REPRODUCTION.

Homothallic.	Heterothallic.	(−)	Neutral.	(+)
1. Sporodinia grandis.	1. Mucor Mucedo.	2	—	1
2. Spinellus fusiger.	2–7. Mucors III.–VIII.			
3–4. Mucors I and II.	8. Rhizopus nigricans.	27	13	19
Heterogamic.	9. Phycomyces nitens.	1	3	6
5. Zygorhynchus Moelleri.	10. Circinella umbellata.	2	—	2
6. Zygorhynchus heterogamus.	11. Cunninghamella echinulata.	2	—	2
7. Dicranophora.	12. Absidia caerulea.	3	2	1
	13. Absidia repens.	1	—	1
	14. Absidia sp.	1	—	1
	15. Helicostylum piriforme.	1	—	3
	16. Syncephalastrum.	2	—	1
	17. Mucor N, n. gen.	1	—	1

In Table III., which contains the species investigated by the writer, arranged according to their thallic character, the figures opposite the heterothallic forms indicate the number of different (+), (−) and neutral strains which have been tested of these species. In addition the writer has a considerable number of cultures which the hybridization reaction would indicate are unmated strains of heterothallic species.

The sexual character of individual strains of all the heterothallic species investigated has remained unaffected when they are cultivated vegetatively. Thus the (+) and (−) strains of *Phycomyces* and *Mucor Mucedo* have been cultivated separately for 92 and 90 sporangiospore generations, respectively, and are as active sexually as when their zygospores were first discovered. Moreover, the two opposite strains of *Rhizopus* have by daily transfers of mycelia been brought to the seventieth generation and by transfers of sporangiospores to the thirtieth generation without the production of zygospores; yet it is only necessary to make sowings together on the proper substratum of spores from the (+) and (−) tubes at the end of the series in order to obtain zygospores in abundance. The homothallic species have also been cultivated to many non-sexual generations, some of them for ten years and over, without change in their sexual behavior. Homothallism and heterothallism therefore seem to be fixed conditions in the forms in which the sexual character has been determined.

In view of the facts summarized, it would seem probable that Mr. Hamaker had been working with impure cultures rather than that he had discovered a new homothallic species of *Rhizopus*. This is further sug-

gested by experiments with zygosporic material which was part of a spontaneous growth on bread exposed in the laboratory of Leland Stanford University. Professor Campbell writes that he has almost always gotten zygospores in this way since 1892, yet an investigation showed that the culture contained but the two sexually opposite strains which were alone incapable of zygospore formation. *Rhizopus* shares with *Penicillium* the doubtful distinction of being the most common fungus weed in laboratory cultures, and it is almost impossible to keep a favorable substratum such as bread in a moist atmosphere for a week without obtaining an abundant growth of this characteristic 'bread mould.' When (+) and (—) spores are in the laboratory, one is very likely to get in spontaneous cultures a growth producing zygospores from the germination of sexually opposite spores which may chance to be together on the bread and, if a mixed sporangial transfer is made from a culture already producing zygospores, one is almost certain to obtain them. That spontaneous zygosporic cultures thus often occur has frequently been experimentally demonstrated by the writer in the Harvard laboratory.

The zygospore of the heterothallic species *Phycomyces,* in germinating, typically produces a sporangium containing both male and female spores.[5] If the germ tube be forced to grow into a mycelium before the differentiation of sex in the germ sporangium, a homothallic mycelium results. The condition in these homothallic mycelia is unstable and the delayed segregation of sex takes place at the formation of spores in the sporangia which they eventually produce. Until this homothallic character becomes fixed, one can not speak of a homothallic race of *Phycomyces;* but the facts already obtained are such that one would not be justified in saying that, in other heterothallic forms, homothallic races may not exist. The experiments with *Rhizopus,* however, render it extremely improbable that this species is other than strictly heterothallic. A few zygospore germinations of *Rhizopus* have been secured, but not as yet in a condition to enable one to analyze the sexual character of the germination.

Although up to the time of the discovery of heterothallism in the mucors the zygospores of *Rhizopus* are found reported in the literature but five times, they can hardly be rare. They are generally covered by the sporangial growth and, to one unfamiliar with their appearance, are distinguishable only with the aid of a microscope. The writer has found them in spontaneous bread cultures in Eisenach and Halle, Germany, and Professor Lloyd and Miss Watterson have obtained them in the same manner in Teachers College, New York.

Rhizopus is not so sensitive to the influence of external conditions in regard to the formation of its zygospores as many other of the heterothallic mucors. The ordinary substrata used in the laboratory are few upon which zygospore formation can not be induced if proper regard be had to conditions of moisture. Carbohydrates are especially favorable and bread makes an admirable culture medium. The writer has in progress a series of experiments to determine the conditions under which zygospore formation is possible in the various species. The fact that in agar cultures with 1 per cent. peptone zygospores have been obtained by the addition of varying amounts of grape sugar from 0.1 per cent. up to 40 per cent., will be sufficient to show that zygospore production in this species is not limited to any great extent by the composition of our ordinary culture media. The temperature is not a very important factor in this instance. Up to at least 27° C., an increase in temperature accelerates the growth and increases the production of zygospores. More or less moisture in the surrounding air, on the other hand, is necessary to the formation of zygospores and, as the writer has already shown (*l. c.*), their production may be suppressed before that of sporangia by sufficient desiccation.

The writer[6] has already described the

[5] 'Zygospore Germinations in the Mucorineæ,' *Annales Mycologici,* **4**: 1–28, pl. 1. 1906.

[6] 'Two Conidia-bearing Fungi, *Cunninghamella* and *Thamnocephalis,*' *Bot. Gazette,* **40**: 161–170, pl. 6. 1905.

method of obtaining the zygospores of *Cunninghamella* by contrasting in cultures different strains of this species. By a sufficient accumulation of material from different sources, one might expect eventually to obtain the two sexual strains and, by their synthesis, the zygospores as well of any form in which the sexes are separated on different mycelia.

Undoubtedly a careful search below the sporangial growth would show that zygospores are more common in spontaneous cultures than is usually supposed. In searching for forms of the mucors, the writer had occasion to make cultures on sterilized paste and on bread of various substances among which the shells of different kinds of nuts were thus investigated. It may not have been a mere accident that in all the several instances in which shells of almond nuts were used, zygospores were produced, but failed to appear when shells from other kinds of nuts were employed. These almond nuts were obtained from different places in the neighborhood of Boston, though they all probably came from the same source originally. The writer would be glad to learn if others have a similar experience with the shells of this species from other localities.

In making cultures, the bread should be raised above the bottom of the culture dish by some convenient object, otherwise the bread is likely to become soggy and attacked by bacteria. Layers of moistened filter paper on the sides and bottom of the dish, which should be covered, ensure a proper moist condition in the surrounding air. Those desiring to have absolutely pure cultures may first sterilize the bread dry and then allow it to soak up a sufficient amount of sterilized water to give it a spongy consistency, after which it may be sterilized with steam for about five minutes. Prolonged sterilization as well as too much water in the bread makes it soggy and less advantageous for cultures. Sterilization is not necessary, however, for class work. Zygospores when present are likely to form in dense masses between the layers of moist filter paper lining the culture dish or in the folds of crumpled pieces of filter paper placed in the culture as traps for their capture. Sporangia form where the air is dryer, and the habit of growth can be readily studied from the filter paper in the upper parts of the culture. The individual stolons can be more easily distinguished if darkened paper be employed. When zygospores are once obtained, mass transfers of the mycelium may be made to new cultures and thus the *Penicillium*, which is a usual weed in spontaneous cultures, may be eliminated. A culture producing zygospores may be dried with its substratum and used from time to time as 'seed' whenever zygospores are needed. Zygosporic cultures of the 'Harvard Strain' have thus been kept running for nearly ten years. The sporangiospores of *Rhizopus* are comparatively short lived, however, and generally do not retain their vitality for more than a year.

For methods of separating out the two sexual strains from a zygosporic culture, which is often a tedious process, one may refer to the writer's detailed experiments with this species already cited.

A. F. Blakeslee.

Halle, Germany.

Results from Moore's Method of Shipping Bacteria on Cotton.

In Science of March 23, Messrs. Kellerman and Beckwith have called attention to the statement in Bulletin 270 of the New York Agricultural Experiment Station that [certain[1]] 'cultures of nodule-forming bacteria dried upon cotton were worthless for practical purposes and that the failure of such cultures was inherent in the method of their preparation.' At the same time they presented some excellent data upon the effect of drying legume bacteria under various conditions. Their most interesting experiment consisted in placing a culture "on cotton half of which was placed in a sterile Petri dish, to make drying very slow, half was dried rapidly and kept

[1] An important word omitted by Messrs. Kellerman and Beckwith in summarizing the statements contained in Bulletin 270.

over calcium chloride. After 25 days the cotton in the Petri dish was sterile; the cotton from the desiccator was a pure culture in good condition, containing numberless organisms." They also found that cultures properly dried and then exposed to moist air died within a few days.

The experiment with cotton in the Petri dish was evidently intended as a repetition of similar experiments given in Bulletin 270 in which inoculated cotton placed in Petri dishes became practically sterile within a few days. The analytical results obtained at the two laboratories were practically identical and it may now be considered fairly established that legume bacteria placed upon cotton according to Moore's method do not survive slow drying. The exact limits of the exposure which they will survive remains to be established.

It should be kept in mind that the present discussion is restricted to certain packages of inoculated cotton which were offered to the public last season and to the methods by which these packages were produced. The point which should be made clear is which of the portions of cotton in the experiment of Messrs. Kellerman and Beckwith most nearly represents these packages. The eighteen cultures discussed in Bulletin 270 were purchased in the market and were the product of a single commercial laboratory. They were repeatedly examined, six of them being tested in each of five different laboratories, and were found to contain extremely few or no living specimens of the desired germ. Their worthlessness for practical purposes was accordingly settled beyond question. Eight other packages of inoculated cotton put up by the same firm but obtained through other channels were examined with similar results.

The method of preparation of these cultures, as stated by the manager of the company to the writer, was to dip the rolls of absorbent cotton into the culture fluid and suspend them in a room until air dry. The cotton was then cut into squares and shipped in pasteboard boxes. Judging from the fact that the germs were practically all dead in the packages examined by us, either the cotton dried slowly or the germs were killed by being exposed to moist air. The chemicals accompanying the cultures uniformly showed the presence of absorbed moisture.

Since this commercial method of preparing cultures included both slow drying and shipment in a package which exposed the cotton to moist air and the germs were actually killed by this treatment, it is plain that it is the cotton in the Petri dish in the experiments by Kellerman and Beckwith which fairly represents the commercial packages.

A careful study of the facts leads to the conclusion that the criticisms justified by our results with commercial cultures are equally applicable to the methods of the Bureau of Plant Industry up to the season of 1905 at least. Until a few months since, the member of the Bureau of Plant Industry then in charge of the legume-bacteria investigation was also in close touch with this commercial company. It was accordingly to be expected that the methods employed in both laboratories would be practically identical and any important criticism against the methods employed in, or the product of, one laboratory would apply to the other. For this reason an examination of the methods employed, and the packages of inoculated cotton put out, by the Bureau of Plant Industry during the past two seasons is both interesting and instructive.

The earliest official description of the bureau's method of preparing the cultures on cotton is given in Letters Patent No. 755,519, dated March 22, 1904, and signed by G. T. Moore. These state that 'absorbent cotton or other equivalent material is dipped into the water containing the organisms or the water containing the organisms is sprinkled upon the cotton or other material and the same thoroughly air dried in a chamber free from dust or contamination by mold.' A more recent and detailed description of the method is given by L. P. Sprague in a thesis presented to the faculty of the University of Vermont on 'The Fixation of Nitrogen by Leguminous Plants,' dated May 1, 1905. Mr. Sprague served as an assistant to Dr. Moore in the Bureau of Plant Industry and gives the following detailed description of the method there employed. "Absorbent cotton of the

best grade, which has been sterilized by heating, without unrolling, in the dry oven about four hours at 150° C., is unrolled and placed in a tin pail, the pail having been sterilized by rinsing in boiling water, and the culture poured over it. The cotton is thoroughly saturated with the culture solution, by pressing and squeezing it with the hands. It is then hung up in the culture room, where it is nearly free from foreign organisms, and allowed to dry, *drying taking place in twenty-four to forty-eight hours*. It is then stored in pasteboard boxes in the laboratory until ready for use. Other methods for inoculating and drying have been attempted, but thus far they have been unsuccessful."

In a recent repetition of our experiments in Petri dishes as detailed in Bulletin 270 it was found that the inoculated cotton under such circumstances becomes air dry in approximately twenty-four hours. Accordingly it is seen that the method of preparation employed by the Bureau of Plant Industry not only is practically identical with that employed by the commercial company above described, but also the rate of drying is practically the same as that in our Petri dish experiments in which the germs placed upon the cotton died promptly.

Our own examinations of the bureau cotton is limited to six packages. While the number of packages is small, it is significant that from none of these packages did we succeed in isolating a single specimen of *P. radicicola* although some of the packages were repeatedly examined. Similar laboratory tests of a number of packages of bureau cotton were made at the agricultural experiment stations in Delaware and North Carolina with similar negative results. The results of pot and field tests at the agricultural experiment stations in Pennsylvania, Oklahoma, Georgia, Maine, New York (Cornell) and Wisconsin as published fail to show any well-marked results from the use of inoculated cotton furnished by the bureau. Two other stations, Michigan and Virginia, have kindly furnished us with a summary of like unpublished tests which are also negative.

Although such may exist it is a surprising fact that thus far we have not learned of a single experiment conducted at one of the many state agricultural experiment stations where the inoculated cotton put out by the Bureau of Plant Industry has given good results.

The marked exception to this wide record of failure is furnished by Bulletin 71, Bureau of Plant Industry. When considering the favorable reports there presented we are forced to conclude that an explanation is to be looked for largely in the psychological, rather than in the biological, realm.

When we consider the methods of preparation, storage and shipment employed by the Bureau of Plant Industry as described by Sprague in connection with the data upon the effect of slow drying and moist air as given by Messrs. Kellerman and Beckwith, an utter failure of the bureau's cultures was the only result which could be logically expected.

H. A. Harding.

New York Agricultural Experiment Station, May 2, 1906.

QUOTATIONS.

ZOOLOGICAL GARDENS AND SCIENTIFIC RESEARCH.

Dr. Gustav Loisel, who is a professor of zoology in the Sorbonne, is making persistent efforts to have the menagerie in the Jardin des Plantes adapted to the needs of experimental science. He would have it so transformed as to become a school of zoological research without at the same time ceasing to be a place of entertainment for the people. Such a plan has been partly carried out in Bronx Park, so that certain fauna are permitted to live and breed almost as if they were in 'the wild.' The experimental stations in this country where marine animals and plants may be studied have proved of the highest value to science; and the laboratory in connection with the Naples Aquarium has long been a favorite resort for naturalists. Two of Dr. Loisel's suggestions are not likely to meet with popular approval. One is to do away altogether with the monkey house, which he says is infected with tuberculosis, and the other is to diminish the number of the more formidable wild animals to make room for beasts whose habits

may be more conveniently studied. But in general there is no good reason why the zoological collections of the world should not be adapted to the needs of students of natural history who should have advantages analogous to those already enjoyed by workers in botany and in the fine arts.—*The N. Y. Evening Post.*

THE WILL OF ALFRED BEIT.

THE public bequests made by Alfred Beit, who died on July 16, were made public in London on July 20, and have been cabled to this country.

The most notable bequest is $6,000,000 to his partners to constitute a fund, the income of which is to be devoted to the construction, equipment or furtherance of any such methods of communication or transportation in Rhodesia, Portuguese Southeast Africa or the German possessions, and any parts of Africa that may be traversed by the Cape-to-Cairo Railway. The trustees are to have absolute discretion, and if two thirds decide that the fund is no longer required for furthering the work of communication or transportation, they can apply the proceeds to educational, charitable or other public purposes in Rhodesia.

One million dollars is left to the University of Johannesburg to build and equip buildings on the land previously given by Mr. Beit; one million dollars for educational or charitable purposes in Rhodesia and other territories within the field of the British South Africa Company; $125,000 to the Rhodes University, Grahamstown, Cape Colony; $100,000 for educational or charitable purposes in the Transvaal, and $75,000 for similar purposes in Kimberley and in Cape Colony.

To the College of Technology, London University, the sum of $250,000 and 1,000 shares in the DeBeers Company are bequeathed, and to the research fund of London University $125,000.

Two hundred thousand dollars is to be distributed equally in London and Hamburg for educational or charitable purposes. To King's Hospital and Guy's Hospital, London, the sum of $100,000 each is given. Mr. Beit's property near Hamburg, which was his birthplace, is left to that city, and his art collections are left to the galleries in London, Berlin and Hamburg.

SCIENTIFIC NOTES AND NEWS.

THE Lavoisier medal of the Chemical Society of Paris and the Hofmann medal of the German Chemical Society are to be presented to Dr. W. H. Perkin, on the occasion of the celebration this week of the jubilee of the coal-tar industry.

THE eightieth birthday of Dr. Georg von Neumayer, late director of the Deutsche Seewarte, which occurred on June 21, was celebrated at Neustadt, where he now lives. An address was presented by Dr. S. Günther, of Munich. It is proposed to establish a foundation for the encouragement of research by geographical students, and arrangements may be made for the painting of a portrait of Dr. Neumayer, to be placed in the Historical Museum at Speier.

Professor Carl Vogel, director of the Astrophysical Observatory at Potsdam, has been elected a correspondent of the Paris Academy of Sciences, in succession to the late Dr. S. P. Langley.

PROFESSOR JULIUS FRANZ, director of the Breslau Observatory, has been elected an associate of the Royal Astronomical Society.

DR. EMIL FISCHER, professor of chemistry at Berlin; Dr. Stanislao Canizzaro, professor of chemistry at Rome, and Dr. Daniel Oliver, lately keeper of the herbarium of the Royal Botanical Gardens, Kew, have been elected foreign members of the Royal Society of New South Wales.

A NUMBER of foreign scholars and men of science have been invited to take part in the opening of the main building of the Carnegie Institute, Pittsburg, in April next. Among those who have accepted are Sir William Huggins and Sir William Preece.

MR. S. F. EMMONS, geologist of the U. S. Geological Survey, in charge of the section of metalliferous deposits, will personally supervise investigations made this summer by members of the survey in various mining re-

gions in the west. He will visit Butte, Mont., and adjoining districts, Ely, Nev., and other camps.

Geologic surveys in the crystalline rocks of northern New Jersey will be carried on this summer by Mr. W. S. Bayley of the U. S. Geological Survey. This work will extend into the Greenwood Lake and Ramapo quadrangles. When it is completed, the entire state of New Jersey will have been surveyed.

The granite deposits and granite quarrying industry of New England will be investigated this summer by Mr. T. Nelson Dale, geologist of the U. S. Geological Survey.

Mr. Homer R. Dill, Gardiner, Me., the state taxidermist, has been appointed chief taxidermist in the new Museum of Natural History of the Iowa State University.

Professor Uhlenhuth, of Greifswald, has been appointed director of the newly-established bacteriological department of the Imperial Bureau of Health, Berlin.

Dr. H. Rosenbusch, professor of mineralogy and geology at Heidelberg, celebrated, on June 24, his seventieth birthday.

The Mackinnon studentships for the year 1906–1907 have been awarded by the Royal Society to Mr. W. G. Duffield, 'for the study of arc spectra of metals under high pressures'; and to Dr. F. H. Scott, 'for the continuation of studies on the nature of the process of excitation of nerve cells.'

Dr. J. Bishop Tingle, assistant in organic chemistry at the Johns Hopkins University, has received a grant from the C. M. Warren fund of the American Academy of Arts and Sciences, to aid in the purchase of chemicals for use in continuation of his investigations of certain derivatives of camphor-oxalic acid.

The Prussian Academy of Sciences has made a grant of 5,000 Marks to Dr. F. Mertens, professor of mathematics at Vienna.

Sir Daniel Morris, commissioner of agriculture for the West Indies, delivered a lecture at the West India Committee Rooms on July 19, on 'The Present Position and Prospects of the Sea-Island Cotton Industry.'

The following popular lectures have been arranged by the Royal Society of New South Wales:

June 21.—'Some Results of Archeological Work in Jerusalem,' by Professor Anderson Stuart, M.D., LL.D.

July 19.—'Our Water Supply from Source to Distribution,' by J. M. Smail, M.Inst.C.E., engineer-in-chief, board of water supply and sewerage, and E. S. Stokes, M.B., D.P.H., medical officer, board of water supply and sewage.

August 16.—"Sir Joseph Banks, the 'Father of Australia,'" by J. H. Maiden, F.L.S., director, Botanic Gardens.

September 20.—'Recent Developments in Long Distance Electrical Transmission,' by T. Rooke, Assoc.M.Inst.C.E., city electrical engineer.

November 15.—'Chapters in Early Australian History,' by F. M. Bladen, F.R.G.S., F.R.H.S. (Lond.).

Nature states that a special meeting was held in the Great Hall of the University of Athens on May 20 to celebrate the fortieth anniversary of Dr. A. C. Christomanos's appointment as professor of chemistry in the university. A large audience, including the Greek minister of education, the university professors and students and many of the general public, was present. Dr. A. C. Dambergis, the professor of pharmaceutical chemistry, referring to the great work which Professor Christomanos has done in the forty years, asserted that the greatest has been the pioneer work in the introduction of scientific chemistry into Greece with the provision for laboratory work in chemistry and the other sciences, and more particularly in organizing so successfully the large chemical department of the university with its laboratory accommodation for 130 students. Professor Christomanos was the recipient of numerous honors, including several from foreign countries.

The students and friends of the late Professor A. Kekulé, the eminent chemist, have contributed about $8,000 to establish a scholarship at the University of Bonn in his memory.

The death is announced of the Rev. John Frederick Blake, formerly professor of natural science in University College, Nottingham, and at one time president of the Geological Association.

DR. A. HÖRMANN, professor in the Technical Institute at Charlottenburg, died on June 30, at the age of seventy-one years.

JUDGE EDOUARD PIETTE, noted for his writings on prehistoric archeology, died at the Château de la Cour des Prés, Rumigny, Ardennes, on June 5, in his eightieth year. Some years ago he gave his valuable collection, chiefly from the caverns of southern France, to the Museum of National Antiquities at St. Germain-en-Laye, near Paris.

THERE will be on August 8 an examination for the position of fish culturist in the Bureau of Fisheries at salaries ranging from $540 to $900.

THE *Experiment Station Record* states that lands have been set aside at Hamakua, Hawaii, for a tobacco farm. Experiments to cover three years are planned, which will be carried out under the direction of the Federal station. The funds for carrying on the farm are to be supplied by private parties.

As a result of the passage of the bill allowing the sale of alcohol without the internal revenue tax, the Department of Agriculture has decided to publish a bulletin on the first of January, 1907, when this law goes into effect, giving the public a collection of the best obtainable data on the use of alcohol in small engines. For this purpose Professor Charles E. Lucke, of Columbia University, has been retained by the department as expert to conduct these investigations in the laboratories of the university. This bulletin will contain all the work done on the subject, both here and abroad, a complete bibliography, together with the results of experiments and the conclusions drawn therefrom on American engines. Those who have patents on the subject or vaporizers, carburettors or complete engines are invited to submit them for tests. These tests will be conducted without expense, except the transportation of the apparatus, and the reports will be published in the bulletin.

THE French government has undertaken to publish the results of Dr. Jean Charcot's antarctic expedition. The Naval Department is to publish the following: (1) Narrative of the voyage; (2) hydrographical results, comprising nautical instructions, description, with views and photographs, of the coasts surveyed, maps and charts; (3) astronomical observations; (4) observations on terrestrial gravity; (5) analyses of samples of sea-water; (6) meteorology; (7) terrestrial magnetism; (8) atmospheric electricity; (9) medical report. Further, the Department for Public Instruction is to guarantee the publication of reports on the geology, glaciology, zoology, bacteriology and botany of the expedition. The two parts will constitute one work, which will be entitled 'The Cape Horn Scientific Mission.'

DR. JOSEPH W. RICHARDS, of Lehigh University, is making an extended journey through central Mexico and will later attend the International Geological Congress.

WE learn from *Nature* that arrangements have been completed for the erection of a commodious laboratory for the study of marine biology at Cullercoats, on the Northumberland coast. A much smaller laboratory, which had been provided by Alderman Dent, the chairman of the County Council's fisheries committee, was accidentally burnt down some few years ago, and the proposed building is designed to carry out, not only fishery research, but also general biological studies. The gift of the site and the cost of erection of the building will be borne by Mr. Wilfrid Hudleston, F.R.S., the management being under the control of the Armstrong College at Newcastle.

The British Medical Journal states that the University of Vienna has delegated several of its geologists, together with two professors of chemistry, to join a body of men of science now at work at Carlsbad, to devise means for securing the springs against telluric and seismic disturbances. Once previously, in 1775, when the great earthquake in Lisbon occurred, the waters disappeared for three days, only to return turbid and changed in taste and temperature. But these changes soon passed off.

UNIVERSITY AND EDUCATIONAL NEWS.

ALL-YEAR-ROUND investigation of problems in fresh-water biology is made possible by a recent provision for a division of limnology in the department of invertebrate zoology in

Cornell University. Dr. James G. Needham, of Lake Forest College, has been appointed assistant professor of limnology to take charge of that work. He will enter upon his duties at Ithaca in February, 1907. A site for a biological field station has just been selected on the Renwick Lagoon at the head of Cayuga Lake. It is accessibly located at the end of a street-car line a mile from the university; it is surrounded by a rich fauna and flora, and is well adapted to the investigations to be undertaken there. The necessary station building and equipment will be provided in the spring. In the future a general course in limnology will be offered in the university, and provision will be made for research students from the beginning.

The council of the Medical Alumni Association of the Harvard Medical School has issued an appeal to the twenty-nine hundred living graduates for subscriptions to increase the salaries of instructors and assistants.

Mr. S. F. Leib, president of the Board of Trustees of Stanford University, and Dr. David Starr Jordan, president of the university, have made public the following notice, under date of July 12: "We desire to inform the students, alumni and friends of Stanford University that the work of the university will continue as usual in all departments for the coming term. The buildings of the inner quadrangle were scarcely injured by the disaster of April. The work of restoration of the outer quadrangle is being pushed as rapidly as possible, and we feel certain that the buildings necessary for the actual work of the university, such as class-rooms, libraries, laboratories and dormitories, will be ready for use by August 23, the date of the entrance examinations for the new term, the registration of students beginning on August 28, and instruction on August 30."

Further details are now announced of the visit of English school teachers to the United States, arranged by Mr. Alfred Mosely. Five parties, each containing one hundred teachers, will come to this country, beginning in November next. They will be given leave of absence with salary by the school, and the steamship companies will give them return transportation for $25. It is expected that reduced rates will also be secured from American railways and hotels. Each party will visit the schools of New York City, and of some section of the country. The parties will be only twelve days each in the United States.

Dr. G. D. Harris, of Cornell University, has been elected to the chair of geology in the Louisiana State University, and will divide his time between university duties and the direction of the geological survey of Louisiana.

Raymond Longley, Ph.D. (Chicago), has been appointed instructor in mathematics and astronomy at Yale University.

At Tulane University, Professor Henry F. Rugan has been advanced to be associate professor of mechanic arts and Dr. Joseph Ivey to be associate professor of mathematics and astronomy.

Professor W. A. Stocking, Jr., has been appointed assistant professor of dairy bacteriology in the State College of Agriculture at Cornell University. Professor Stocking has been connected with the Connecticut Agricultural College and Experiment Station the past few years.

At New Hampshire College, Instructor Charles Brooks has been made associate professor of botany. Mr. F. W. Putnam (Worcester, '99) has been made assistant professor of drawing and T. J. Headlee, Ph.D. (Indiana, '06), assistant entomologist. In the chemical department Mr. Charles James, who obtained his training with Sir William Ramsay, has been appointed instructor.

Mr. Paul Langer, of Milwaukee, has been elected acting professor in the technical institute at Aachen.

The Experiment Station Record states that a chair of fishery and fish breeding has been established at the Agricultural High School of Berlin and will be occupied by Dr. P. Schiemenz, director of the Müggelsee Biological Station, which now becomes a department of the Agricultural High School.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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TO WHAT EXTENT SHOULD THE UNIVERSITY INVESTIGATOR BE FREED FROM TEACHING?[1]

THERE can be no single, direct answer to this question. The answer depends on the man; on what he is doing or how he is trying to do it. And if the man be really a capable investigator, he will be most competent to answer this question for himself. There is then no collective problem admitting of a single answer. The important element lies in the premise that the university must foster research as an integral part of its work, for its own sake as an institution, and for the good of humanity. It is research which has made universities possible, and they must provide for the continuance of the succession. Again, teaching without research is not university teaching. In this sense, we must give a broad definition to the word 'research.' Teaching from second-hand sources is never good teaching.

It is the duty of the university to discover, to coordinate and to disseminate truth; and with this, to train scholars and workers, and to develop personality and character. In this many-sided work all members of the university should take some part, but this part in the nature of things must be very unequal; not many men excel in all phases of university usefulness. Some rare men are useful in the highest degree—but in one line only. Around those preeminent in the discovery of truth, chairs of investigation may be built up.

[1] Read before the Seventh Annual Conference of the Association of American Universities, held at San Francisco, Berkeley and Palo Alto, California, March 14–17, 1906.

But the man should always come before the chair. It is futile to frame a chair of investigation, and then to seek a man to fill it. In general, the investigator who can not teach at all is subject to some defect of temper or to some deficiency in health.

As the world goes, with men of our breed, the primary value of research is in relation to teaching. 'The real teacher is the man advancing in some direction' (T. H. Morgan). Many sorts of mental effort go by the name of research, and properly so. These range from first-hand study of well-known problems through all phases of case-counting and hair-splitting—the rearrangement of old material and the description of new—up to competent and courageous excursions into unknown realms of thought and observation. Some may go far and bring back rich returns, some go but a little way and bring back new aspects of old surroundings, but all should go somewhere and bring back something. It is not needful that all departments should adopt the same methods in research. I see no reason why Greek literature, for example, should be treated as though it were a branch of histology, and history need not be stated in terms of chemical reactions. It does not make work scientific to make it hard. All fresh work is desirable, all should be encouraged, though to most men, even university men, only the simpler forms of research can ever be possible. A man of no great talent for scientific pioneering may be an effective teacher, but a man whose grasp of facts and principles is wholly second-hand can never be such. However old his conceptions and however often his thoughts have been expressed, he must derive them afresh from nature if he is to make them vital to others. To the extent that he does so, he is engaged in a form of research. It is his instinct for first-hand contact, the joy in dealing with realities, which is essential to the great teacher, and these traits are primarily those of the investigator also. The instinct for research grows with practise. It is never safe to let it die. Hence the importance of continuity in investigation and the need of it for the teacher at all stages of his development. A man capable of research will do something of it wherever he is and whatever his limitations. In Huxley's phrase, it is 'the breath of his nostrils.' With time and appliances he will do more work and better work, but you may know the real university man by the fact that he does some work which is his own, even under the most untoward conditions. He is safe so long as he is growing. A growing man incites growth, but not even mold will grow on a fossil.

The American university is emphatically a teaching university, to borrow the English distinction of schools that teach from schools that examine. Its professors are teachers. They are not primarily examiners, as in the English universities of all classes, nor do they have the freedom from personal responsibility that is often assumed in the universities of Germany. For the rank and file of our university men, teaching is the main function, and investigation receives its first value from the fact that adequate teaching is impossible without it.

In general, the university professor recognizes his double duty, his actual work as a teacher, and his duty as an investigator to become a better teacher. Some teaching in general aids investigation; it clarifies the mind, broadens the view and saves from vagaries. Teaching and investigation in a general way are mutually helpful—if the combination is not carried too far beyond the fatigue point. This varies with different subjects and with different men. When the two conflict, investigation is likely to suffer. Research can be postponed; teaching can not. Too much teach-

ing breeds brain fag, which kills the joy of knowing and doing. Here again the personal equation comes in, and to a larger degree. Some men do their best work gregariously—directing, controlling and stimulating the interest of others. Some can work well only when alone and undisturbed. Some kinds of work demand uninterrupted attention for a period. Some require special visits to libraries, to museums, or to distant lands. All these matters should receive consideration by university authorities. The plan of giving each year, on full pay, absolute freedom to one or two professors engaged in research, the same privilege later to be extended to others, is one which deserves general adoption. This absence should mean a year for work, not for rest, nor travel, nor for writing text-books. The present sabbatical arrangement will serve for these, but the pursuit of science demands something more than half-pay furloughs. The university authorities should consider these things, and so should the competent worker who must be the final judge of his own work and his own needs.

An obstacle in the way of this and various other forms of relief which inure to the gain of the university lies in the need of personal discrimination, to which governing boards are painfully averse. The mediocre worker is with us, as well as the man who can not investigate at all. A form of senatorial courtesy obtains in all university faculties. Without it, team work, or work as a cooperative body of scholars, would be impossible. But this very fact forms an obstacle to the relief of those men who could make the best use of freedom.

Among young men who have done a little work, there is too much conceit of research, and overmuch desire to secure at once its rewards. Research pays its own way and asks no reward. Moreover, overmuch cackling indicates that eggs are really small and few. Not all who talk of research, even in Germany, shall enter the kingdom. Perfunctory work, work done for the purpose of catching the attention of the easily deceived college president, work done to be heard from, all these count for very little. Freedom from teaching might only increase the quantity, making its badness more visible. This fact the Carnegie Institution has served to make plain, in its dealings with some of our callow doctors of philosophy.

Moreover, the real investigator will follow his own bent. The disposition of our young men 'to paddle in the same pool,' to rush toward each new field where something is proposed, is a symptom of incompetence. There are fads in investigation, and while the fad is on, the product is scanty. In general, all fields of research are open alike, and they have always been open. Each excursion into one of them is rewarded according to its deserts. In this quest single-heartedness and broad-mindedness are the elements which count for most. Cleverness, technique, speed, self-confidence, facility, versatility, perfection of method even—all these are matters of equipment of minor importance. Too often novelty in work is unduly exalted. Much which we call method is only the trick of making a very small discovery appear epoch-making through bolstering of bibliography, philosophy and historical criticism.

In general, the investigator will wish to publish his results. The instinct of the teacher impels him to do this. Yet it is true that publication is a very poor test of research. Some men keep their results for years—for many years—holding them until their conclusions are ripened, their suppositions verified. A voluminous bibliog-

raphy does not necessarily mean contribution to knowledge. It does not even imply originality of thought or breadth of observation. It is quality that counts, and a single fact well tested and set in orderly relation may outweigh volumes of argument or theory. Under the stimulus to get into print, very much is now put forth which university men everywhere feel might be better dropped into the waste-basket. This would be its final fate, printed or not, were it not for the demands of blindly conscientious bibliographers. Some twenty years ago I used these words:

> I am well aware that there is a cant of investigation, as of religion and of all other good things. Germany, for example, is full of young men who set forth to investigate, not because they 'are called to explore truth,' but because research is the popular fad, and inroads into new fields the pre-requisite to promotion. And so they burrow into every corner of science, philology, philosophy, and history, and produce pretty results in as automatic fashion as if they were so many excavating machines. Real investigators are born, not made, and this uninspired digging into old roots and 'Urquellen' bears the same relation to the work of the real investigators that the Latin verses of Rugby and Eton bear to Virgil and Horace. Nevertheless, it is true that no second-hand man was ever a great teacher. I very much doubt if any really great investigator was ever a poor teacher. How could he be so? The very presence of Asa Gray was an inspiration to students of botany for years after he had left the class-room. Such a man leaves the stamp of his greatness on every student who comes within the range of his influence.

University authorities must, therefore, not fear to become respecters of persons. They should give time, freedom, appliances, where these things can be used, while refusing them to the man who would thereby merely advertise his own insignificance.

The valuation of research is, at best, a difficult problem. Much of the results of hard labor would be better left unpublished, and the valuations set by the authors will not be recognized by the workers of the future. Spurious research is worse than nothing. The pressure to print something is responsible for much of it; the leisure of fellowships for much more. Only a few men can make use of leisure. Moreover, leisure without adequate salary avails little. The busy man under the pressure of poverty, edits texts, writes cyclopedias, throws out potboilers of every kind available to his profession. This is not research. It may be respectable, but it does not develop originality nor mark progress.

In the American university of to-day we teach too much, too many hours, too much that is not worth while, too much to people who do not care for this teaching. We teach at too low a tension, with too little enthusiasm, too little inspiration, throwing too little responsibility on the students, showing too great patience with those not worthy to accept responsibility. The men we call professors are paid too little, helped too much in their early preparation, promoted too rapidly and above all with too little discrimination. It would be better for our universities if half our teachers were in some other profession—if the best half were the ones who remained. This will not be the case until our present scale of salaries is advanced. There is too much encouragement of 'digs'—men with technical accuracy but without personal force or originality or skill in interpretation of new material. There is too much toleration of volatile versatility and of the methods of the Sunday supplement. In our profession it is too easy to get into line for promotion, while promotion itself ought to carry more pay, more freedom, and with all this far higher responsibilities than those we now demand.

Some large degree of freedom from teaching should, therefore, be accessible to the investigator, and this freedom can only be stated as a principle not reduced to rule

or set forth in terms of hours or percentages. But as teaching is itself dear to most true investigators, there are other lines of freedom still more important than relief from class work. The work that kills is not teaching, but the routine which goes with teaching. When I accepted my present position, Governor Stanford told me that he thought the president of the university should do nothing he could hire some one else to do just as well. The university professor should be placed in just this position. Everything that can be just as well done by some one else should be taken from his shoulders. He should have a stenographer, a reader, an artist, an artisan, a 'Diener,' all the helpers who can save his time and add to the dignity and strength of his work. A certain amount of executive work, even of committee work, he should be glad to retain—for the American university is a corporation whose affairs need constant vigilance on the part of somebody. In the long run, its greatest scholars are its wisest men, and in their hands its control should finally lie. The highest type of investigation demands many of the qualities which make a man successful as an administrator. Moreover, it would be a pity and a misfortune to have academic management fall into the hands of those not in sympathy with the highest functions of the university itself. It is not the business man, but the man of science, the man of learning, who should direct the internal management of the university. Those who do not understand the scholar's business can not properly direct the scholar's activities. It may be a matter of regret to use our scholars for executive purposes, but it will go hard with scholarship if the scholar loses control. It is surely a mistake to suppose that any scholarly gentleman who becomes a professor can train investigators. It is the master's touch which awakens the latent instincts of the student. Only the university man can create the university atmosphere.

It is not well that even the best of university men should be freed from responsibility for the welfare of the university in all its interests. Leisure without responsibility is dangerous to all save the greatest. This the English universities have demonstrated, though they have not acted on their knowledge. The fellows of Oxford and Cambridge are provided with life-stipends that they may devote themselves freely to teaching or to research. Half of these men are doing nothing even remotely connected with scholarship. With many of them, fox-hunting occupies a higher place than philosophy, and the drink from the Pierian spring is replaced by simpler and more familiar beverages.

Among endowed investigators in Europe, it is no uncommon thing for a man to say, 'It is time for me to produce another paper; research is due this year again.' Then the investigator hunts through the museum or the library for some topic which will yield the maximum of pages with the minimum of labor.

I do not think that men have often succeeded in research unless they have rejoiced in such work, unless it is the spontaneous expression of their natural activities. Such joy in production gives no guarantee that the work shall be good, but it gives the basis on which training can be made effective.

I can not agree with those who regard university professorships for research alone as one of the primary essentials of the American university. We should not divide our men into research professors and teaching professors. It is not good for the universities that among its varied helpers we should recognize distinctions of caste, nor should we try to develop one group of professors as higher than another or apart

from it. Professor N. S. Shaler has well said:

I believe that no teacher should be so burdened with instruction that he can not do inquiry to a reasonable extent. If he accepts the office of teacher he must make that work his principal end. He should understand that inquiry is necessary to fit him for teaching.

I think that the effect would be bad of having certain men set aside as inquirers even for a part of their time. It would tend to increase that already painful division of our instructors into men who are alive and men who are dead. A man should look upon research as he does on traveling—something that, if he is a breadwinner, he has to take by the way. Only a blessed few who have the rare combination of money and purpose can devote themselves to it.

In the same vein, Professor James Perrin Smith observes:

One teaches better by example than precept, and every university professor should be an investigator in the work that he teaches. But routine teaching must be done and the setting aside of a certain number of men as a sort of priesthood to do nothing but research will make the burden of teaching fall more heavily on the less favored ones, some of whom may contain the germs of real contributions to science or literature. In this way both the research and the teaching will tend to become poorer.

Dr. John C. Branner says:

I do not think that every one who is interested in or capable of carrying on investigation has, or should be encouraged to believe that he has, some sort of right to a professional position. Every professor (not emeritus) should be required to give an important part of his time to personal instruction or to the supervision and direction of instruction. At the same time, the professor who is not engaged in research of some kind is not a fit person to be a professor, though he may be a valuable man for giving certain kinds of instruction. Such a person should not be promoted beyond a subordinate position.

My final answer to the question before us is this:

The university should recognize the necessity of research to university men and in a much greater degree than is now the case in any American university. It should provide for this in the way of all needed appliances, material, books, clerical help, artists, assistants, leisure and freedom. These needs can not be enumerated categorically, for they must vary with each individual man. Among them should be named provision from some source to ensure adequate publication. The plan of granting regularly to one or more professors each year a research leave of absence or of freedom from all other duties is especially to be commended. Each competent investigator can be trusted to indicate his own needs; the university authorities need concern themselves only as to his competence and their own ability to respond. Leisure without responsibility serves no useful purpose, and adequate pay is necessary to give fruitfulness to leisure or freedom. Men should not be encouraged to undertake research in order to gain professorships. Rather they should gain professorships in order to make research fruitful. A university need not provide for research fellowships or research professorships. If it possesses the man of a thousand who can be best used by such provision, it can build a chair about him and his needs, this chair to be abolished at once when the incumbency shall cease. We should grant freedom from cheap and sterile activity—from reading papers, sharpening knives and copying letters; from superfluous committee meetings and from routine work any subaltern could do just as well; and, above all, from the thousand makeshifts of poverty. This relief is far more needed than relief from teaching.

Once in a generation [says a correspondent], perhaps appears a man whose work is so important that he should be entirely freed from instruction, and as much as possible from administration; Darwin is an illustration. Otherwise, the importance of bringing the men of first and second rate training and working power into contact with receptive pupils is so great as considerably to outweigh the value of any scientific investigations

they might make if left entirely free from teaching—Agassiz is a case in point. Anton de Bary was one of the ablest investigators of his generation (he died in 1887). But all his brilliant work would sooner or later have been accomplished by, not one person, but a considerable number of other people, and as it lay in the then advanced field involving microscopical appliances and technique, the great improvement in modern methods has enabled inferior men to do some of his work better than he did it, and clear up difficulties he left unsolved. His influence, however, as a teacher can not be overestimated. The men who received inspiration and training in his laboratory are among the leaders, and what is better perhaps, are among the sanest influences in botanical work in their generation. Again the pupils of de Bary's pupils are among the best influences of the younger generation.

In his students the work of a great investigator is multiplied a hundred or a thousand fold. To be thus remembered, to live thus in the spirit and methods of the generations in science that follow after us, this is for us, as university teachers, as university investigators, as men who teach through the method of research, the noblest type of fame, the worthiest conception of personal immortality.

In the preparation of this address I sent a circular note to about a hundred leading university men, and I have received a singularly valuable and suggestive series of answers. Most of them agree in a general way with my own views already stated, or more exactly, their agreement has helped me to form my own final opinions with more precision and more confidence. Some of them state recognized principles with novel force, while a few others hold views unlike my own on one or two phases of the question. A few are partially satisfied with present conditions, believing that these matters are self-regulating and that the universities are doing all that can be done under present conditions. A few again place a higher value on the young enthusiast who thinks that he can investigate what he can not teach, and others still are more tolerant towards the man who can teach what he can not investigate. One correspondent places especial emphasis on the value of leisure, even though for a time our university men may not know how to use it. He says:

I think, in general, that the great lack in the American college and university is lack of leisure. The ideal seems to be that of 'keeping busy' both the faculty and the students. More show of activity is thus made, and trustees are better satisfied. I believe, on the contrary, that a certain amount of guaranteed unoccupied time every day should be a distinctive feature of the academic life, both for student and for professor. Of course, if leisure were suddenly granted, we should neither of us know what to do with it and how to use it rightly. But we can't learn how to use leisure aright without having some little leisure to use. Reform might come gradually. America, it would seem, has combined the English way of keeping its instructors occupied all day with the German idea of extending the working year over three quarters or more of the solar year. But the English tutor gets more than six months of the year to himself; and the German professor lives a much more leisurely life than the American professor can do. The consequence is, I think, that both the Englishman and the German are, at their best, better academic men than we American professors can be.

This leisure I should give to everybody, and I believe that the granting of it would in essentials answer your question. But I add this: I do not think that the number of men capable of doing research work is anything like so great as one would gather from the scientific journals (SCIENCE, for instance), or from the general atmosphere of faculties. The tacking-on of a graduate school to the college and the implicit idea that every holder of a chair can direct if he can not himself accomplish research work, I take to be wrong and mischievous in the extreme. In England, as there are among the students pass-men and class-men, with no jealousy or rivalry or thought of superiority or inferiority, so there are among the teachers men who are appointed mainly to teach and men who are appointed to research offices. I think that this division should be drawn in American faculties. It should be frankly recognized that the majority of professors, however excellent their method of instruction and

however wide their knowledge, are not fitted or expected to carry on original investigation.

Now to the definite answer to your question. If under existing circumstances a man is found who is capable of extended research—one who can attract young graduates to him, give and take fruitful ideas with them, found a 'school' of sound scientific inquiry—then I should think that such a man ought to be highly cherished and privileged; that he should be called upon to set his own amount of teaching work. Some teaching, especially to the very beginners in his subject, he would probably always want to do. But he should, in my opinion, be freed from the intermediate work of imparting information to students in the mid-period of their training. That such a man should be required, day in and day out, to give his best hours to the routine of instruction, has always seemed to me to be a bit of sheer folly on the part of university authorities.

I am obliged to append a postscript. It is useless to grant leisure, whether to all alike or to a favored few, unless an adequate salary goes with it. It is pitiful to see men who are able to do new work spend their summers in summer schools, or devote what scanty time they now have to routine work for the press, for cyclopedias, etc. Even the arrangement of the sabbatical year is really farcical for men who have only their professorial income to rely upon: to take it one must either have 'married money' or have written a successful text-book whose sale adds to one's income. If professors engaged in research were relieved from the work of instruction, with no further change made, I am afraid that they would at once begin—most of them—to devote their leisure time to the acquisition of scholarly appurtenances and various comforts of living: I do not think that the output of research work would, at least for some time, materially increase.

But leisure without responsibility rapidly deteriorates, except with the superior man, to whom all things are possible. The fellowship system of Oxford and Cambridge in hundreds of cases has degenerated to simple graft, with the same evil effect on English education that American forms of parasitism have had on our own local politics. The sinecure and the examination paper are the two burdens borne by higher education in Great Britain—evil influences from which the American university is relatively free, though every land has its own troubles. There is, again, a distinction between instruction in a man's own line of work and the so-called routine teaching of elementary facts to boys without interest in them. The doors of our universities ought to swing more freely both ways, and the student who doesn't care for his own education should find a way out more readily than he does now.

A few of my correspondents emphasize the value of research professorships as corrective of the tendency to regard routine work as the whole function of the university. Without going quite so far as some others, one correspondent has the following suggestive words:

> The burdening sense of accountability under which the American professor suffers is to my mind the real danger point of the situation. * * * It is the advancement, even the rehabilitation of the academic career, that is concerned. To render that career an inviting one for the ablest minds, to give the career the recognition—social, financial; in honor and dignity and general esteem—that it should have to serve the intellectual interests of the nation best, is the larger end in which your special problem finds a place. The present status of the professor lacks much that is desirable and possible; and part of his difficulty lies in the interpretation of his duties, and even more in the emphasis of that portion of his activities for which he is most esteemed, most rewarded. At present I should say that his advance in most institutions depends upon his serviceability to the university on committees and in its general administrative business; and next upon his ability to achieve a certain sort of popularity amongst the students. To subordinate these modes of estimating his services to the far more essential traits that give worth to a man's services, decided influences should be set into action. Among them I should attach high value to any emphasis of the value of research as an integral part of a professor's life work, as one of the preeminent considerations that justify his place in the university faculty. Any such recognition seems to me a decided, and at the moment a much needed, step in advancing the academic career; and for this reason my view upon your special problem takes decided and emphatic shape.

I believe that a large measure of elasticity should enter into the definite assignment of duty, that the minimum requirements should be small. We can not accept either the German, French or English view of the situation. We hold a man to a far more rigorous task, leave less to his decision than do any of these foreign institutions. Our professors are more distinctly engaged to teach. Yet it seems to me so hopeless to look for the career of research in many departments of learning outside of the universities, and its presence in the university is so helpful, that the wiser solution seems to me frankly to include the research program within the larger cultural and practical ends for which universities exist, and thus to afford the professors whose interests lie that way the largest possible relief from teaching, to devote themselves to so integral a part of their function as investigation occupies.

This should apply as well to the younger men. The great point that is made in favor of the German 'Docent' system is that it leaves men free at the most energetic periods of their lives to pursue their own interests. They are accountable to no one; have acquired the privileges of teaching, but no duties other than those voluntarily assumed; they are to work out their careers as freely as they like, and frequently are given the facilities that they need. This again we can not do; but I believe it may stand as an emphasis of the influences that our universities can wisely cherish, though they must use other means to express their esteem of this part of the academic career.

I do not see how the practical side of the issue raised can be met by any formula. Having expressed the trend that seems to me to be worth favoring, the actual determination of ways and means involves a series of practical considerations, often of local considerations, that resist formulation. Taking the provisions that the most enlightened of our universities make for research (and they are considerable), I am willing to venture the opinion that these could be distinctly and liberally enlarged without, in my opinion, rendering the universities open to the charge of overemphasizing this portion of their functions, or of failing to interpret properly the functions of the professor and his duties towards the university from which he obtains his support.

Another correspondent attacks one more phase of our difficulty, the waste of our resources through trying to do too many things. He says:

The chief factor in determining from decade to decade the actual course of study in American universities has been, as I think, the pressure of new subjects for recognition. This pressure changed the pressure of seventy-five years ago, with its slender list of subjects, into the curriculum of forty and twenty-five years ago, whose aim was to compress a bit of each sort of learning into a four years' course. When this became impossible, two courses of study were made and then three. The ground must be covered. No one student could cover the ground, but the catalogue must do so.

The same pressure, growing always greater, caused the so-called all-round course of study to blow up from within, leaving its debris in many new and strange forms of educational practise. * * *

Finally, the same pressure which has caused the multiplication of departments has caused the multiplication of specialties within departments. Science has developed such and such new fields of learning. They demand recognition. They are recognized at such and such institutions. We must recognize them here. We must cover the ground. No student can cover the ground, but the university must do so.

If a university were rich enough to cover the whole ground of learning with first-rate introductory courses on the freshman-sophomore level and then to cover the whole ground again on the junior-senior level, with a vast array of electives, and finally to support research in a correspondingly adequate measure, we might say let it be so; let this limitlessly rich university do by itself what it is really the business of all the universities and learned societies combined to do. It is fine to imagine an institution where every science and every art might be studied upon every level, with no lack of money or of men, or of leisure for the men who do productive work. It is not surprising that this splendid conception, which must be the ideal of the university world as a whole, should be more or less consciously the ideal of particular universities. But in point of fact, the whole university world is not at present rich enough for the full realization of this ideal. And when a single university, even the richest, attempts to do everything on every level, the inevitable failure of the undertaking is sure to appear in some way.

The failure does appear very generally in two well-known ways—first, in the cheapening of the elementary collegiate work; and second, in the restriction of productive research work.

It is said that in the American university there is a necessary internal conflict between the collegiate interests and the university interests. My judgment is that in the larger American universities generally, the greatest enemy of both these interests is the excessive expansion of the course of study.

* * * * * *

There are obviously two ways of cutting down the amount of work which the university shall offer. We may cut down the number of departments, or we may cut down the number of courses offered by the several departments.

The first of these methods is radical. It is a grave matter to abolish a university department—not really more grave, I think, than the establishment of a new department whose justification may be doubtful but for many and obvious reasons a procedure which university authorities must hesitate to adopt. Nevertheless, even such radical pruning may be justified. It can become a question between cutting off some large limbs and the languishing of the whole tree. I shall not be surprised if within the next generation the pressure of circumstances should force the universities to the adoption in a considerable degree of this extreme form of selection.

Meanwhile, we have at hand a much gentler and yet scarcely less efficient method of selection if the departments will cut down the amount and range of work offered by them. Let me put this method of reorganizing and concentrating the course of study in the form of definite proposals. Let there be in each principal university department:

1. A fundamental elementary course.

2. A very strictly limited amount of undergraduate work beyond the introductory course.

3. All the rest of the work offered by the department strictly graduate or research work.

* * * * * *

Without affecting the number of majors or of groups or of departments, we may very decidedly reduce the number of undergraduate courses offered. Here, as I think, is the place for the pruning knife. The universities can cover the whole field of learning in typical introductory courses on the freshman-sophomore level. We can not each of us by any possibility cover the ground on all higher levels. We must select. We must reject, right and left, subjects which have every argument in their favor except that we can not do them all. We must weed out the suckers as a condition of having cornstalks.

There would result apparent hardships for the undergraduate and for some members of the faculty. The undergraduate would not be able, on the one hand, to take a large proportion of his college course within one narrow field, thus becoming a specialist without becoming an educated man; and he would not be able on the other hand to browse far and wide over any and every field which modern learning has developed. He would find instead, however, an abundantly wide choice of majors or of groups each offering an austerely chosen list of representative courses arranged so as to make a substantial center for a college course. And this, whether or not he is to become a specialist, is, I believe, the best thing which the university of to-day can offer him.

I have considered in this connection also the possible hardship to the younger professors who want to have each at least a small amount of advanced work to do. I do not wish to slight this consideration, for it is an essential feature of the university life that the younger men should have the door of hope open. I have not solved this problem to my own satisfaction, but I say this: If an instructor can do important productive work, the university should try to offer him as much leisure as the value of his work appears to warrant, whether he is doing the work with students or alone. What the university can not afford to do is to pay so dearly for elementary, non-productive junior and senior work. These courses are the suckers.

3. Productive work. The freshman-sophomore fundamental courses should be the first gainers from the resources of money and leisure saved by cutting off excessive expansion. The second gainers should be the graduate and research courses. I wish to consider this second gain as it might affect the larger universities and then as it might affect the smaller ones.

(*a*) Our greatest universities are very rich. They have great graduate schools. They have scholars who have proved to be productive men. And yet, when the total output of scholarly work done in them is compared with that done in Germany, for example, the result is generally conceded to be discouraging. In many cases, little is accomplished beyond the comparatively elementary research work which has its terminus in the doctor's degree. No explanation of this result seems so probable as the fact that the German professor has, as a rule, the leisure which the American professor only secures by exception. It is doubtful whether the German rule can or should become the American one while we have the college and the university united in one institution. We wish

our greatest scholar to surrender a little of his time to the freshman. But having asked this of him as a duty of religion, we should spare his leisure as the most precious asset of the university. We should count it a sin to require such a man to 'cover the ground.' We should sacrifice the catalogue, make it thin and full of holes, confine the students to a narrow range of typically good choices, and by these inconsequential sacrifices preserve for the great man his chance to do the work which he alone can do.

(*b*) There is an evil suggestion in the air that a university should not attempt to do advanced graduate and research work unless it is very rich. I know of nothing to justify such a counsel of discouragement. The history of learning, the history of the little universities of Europe, the current history of scholarly work in America, all show that the conditions which permit a man to do productive work may be created anywhere. At the worst, some men in the smaller universities, in the little colleges, and in whatever places may seem more unlikely, will continue to prove that creative work is free for all and is the one thing which can never be controlled by a monopoly. Wherever these men are, they prove also, directly through their pupils or indirectly through their colleagues, the vitalizing effect of research upon teaching, and so demonstrate the true bond of unity between the university and the college. No institutional conditions can wholly suppress these matters of the guild of scholars. It is, however, our main business to organize conditions which shall not tend to repress them, but which shall enable them to give their whole service to society.

In conclusion I will say that the problem of selecting from all the things which might be done the things which shall be done is the most difficult and the most imperative problem confronting the whole school system. It is not an artificial problem. The school must represent civilization. When we have detected and dismissed the fads and frills, there remains the great circle of sciences and arts which will not suffer dismissal and yet for which our long and expensive school system has not yet found enough money nor enough time. This means simply that the school has forced upon it as never before the problem of selecting its course of study.

Some of my correspondents plead for years or half years to be devoted exclusively to research. Others think that research and advanced instruction should go on simultaneously. Still others hold that the elementary student has a special claim on a little of the time of the master. Manifestly these are special cases to be treated each in its own way according to the man and the subject.

In a recent address Professor George H. Nuttall calls attention to the utter inadequateness of the provisions for research in universities or outside, in both England and America. Irrespective of the universities there should be an open career of investigation and in all the various fields of science. Such opportunities exist to a limited degree in our scientific bureaus, surveys and experiment stations, but these should be greatly multiplied, at the same time leaving them open to real talent only.

Says the London *Times:*

In one way or another every branch of research loses promising men, who either go into practical affairs with what knowledge they have or make research itself subservient to money-getting by selling crude inventions, by self-advertisement, or by cooperation with financiers. We have no hierarchy of students on a living wage basis; and as a consequence we are very short of real teachers even for practical purposes. For the real teacher must be an advanced student, not a mere parrot reciting other men's work.

Another correspondent believes in the exclusion of hack work, summer schools and other matters of minor importance which tend to lower the intellectual tone of the university professor. He says:

In cases where a chair is endowed for the expressed object of research, I would go so far as to say that the professor should not only not be required to lecture, but should not even be allowed to lecture, except, if he desires, he might give a course of not more than a dozen lectures confined strictly to an exposition of the subject on which he is engaged in investigating. Such chairs are very few in number, but still there are some. My reason for prohibiting lecturing in such cases is that there is always a temptation in universities for a professor to create a following by appealing to an audience, and the tend-

ency is to lecture more and more, with a loss of time and energy which should be spent on research itself.

Where it is not specified that the professorship is for research, my answer would be that the amount of relief from instruction ought to depend largely upon the qualifications of the professor himself. Some professors who are good lecturers and teachers and valuable as such are not by nature qualified to be investigators, except in a very limited sense. I see no reason why such persons should be relieved from doing what they can do well, on the chance that if relieved from lecturing they might do original work. At the present day there is connected with investigation an idea of superiority over the mere exposition of a subject, and most professors desire to be regarded as investigators. If, however, experience makes it probable that a professor is a good teacher but a poor investigator, I see no reason why he should be relieved of lecturing.

There remains another and a large class of professors, some of whom are good lecturers and teachers, and some of whom are not, but who have a capacity for good, original work, if allowed time for it. It is to this class of students that your question, as I understand it, especially applies. In this case it seems to me that the nature of the subject in which the professor is an expert should be considered. In the more special and technical subjects, those in which the largest additions to the stock of the world's knowledge is to be expected, but where that knowledge, when obtained, is such that it can be absorbed by a comparatively few advanced students, my opinion is that the professor should be allowed at least half of his time—or, better still, more than half of his time—for his own special work, and have the amount of his lecturing and teaching correspondingly reduced.

Other subjects, as, for instance, certain branches of political economy and history, and possibly branches of chemistry, physics and biology, are of such a nature that it may be expected that the results will be of immediate value to a considerable number of students, who, furthermore, should be encouraged to become themselves investigators. In this case it is desirable that the professors should not be so pressed by the work of instructing and lecturing that they have not sufficient time and strength left for individual work in investigation. During the college term, it seems to me that such persons should be allowed at least one third of their time for their own original work, and, what is important, *all* their college vacations.

This last point seems to me to be important, especially in subjects like biology. The tendency is to increase the number of courses in what are called 'summer schools,' as they attract students who increase the total enrollment of a college. I object strongly to having those whose whole time during the college year has been spent in lecturing and in original work, called upon to take classes in a summer school. By all professors who amount to anything the three months of summer vacation are not spent in idleness, but used for original investigation or preparation for the lectures of the year to come.

A correspondent makes the useful suggestion of occasional research professorships to be held for one year. In such appointments, work well under way should have precedence over work contemplated or merely begun. He says:

It seems to me, also, that our great universities would find it a wise policy to have each a small number of highly paid research professorships, which might perhaps not be each for any specific subject, but be assigned from time to time to members of the faculty, somewhat as fellowships are now assigned to superior students. It would add greatly to the attractiveness of university life if professors could feel that there was a chance of having their salaries kept up while for a year or two they were left entirely to devote themselves to investigation.

From others whose views in the main coincide with those of this paper I may quote a few well-put paragraphs.

A correspondent says:

I believe that the professor is, or ought to be, primarily a teacher, and that his first duty is toward his pupils. But I think that mere instruction-giving is the lesser part of his calling. It is teaching by example that best takes root, and it is the leadership into fields of new truth, of the few who have the zeal to enter, that brings the largest and most permanent returns both to the professor and to his institution. The university has a right to expect of the professor that he will give the impress of his personality to both the administration and the teaching of his department. But it has no moral right to demand that he spend all his time and energy in departmental drudgery. To what extent he should be relieved of this in order that he may engage in research will depend on many things—among

others the man, the state of his department, and the stage of his researches, an important work that is nearing completion being more worthy of concessions than one just beginning.

The making of conditions for research is but a just acknowledgment of the debt the universities owe the world of knowledge, and is the first step towards its repayment.

Another says:

Assuming the command of adequate resources, it seems to me that the extent to which professors engaged in research should be relieved from instruction is essentially an individual question, the answer to which is dependent on the relative values of the professor's work in research and in instruction. If the research is of exceptional value, the instruction should be limited to that which relates to the field of research or is tributary to it. Thus much is usually helpful to the research. If on the other hand the instructional work has markedly the higher order of merit, the research work may well be limited to that which is helpful and tributary to the instruction, as a certain amount is assumed always to be. The intermediate cases may well be subjects of special adjustment on lines intermediate between these two, precedence being given to research when it is really productive.

Another says:

Men differ in regard to the relation between research and instruction. The true investigator is born, not made, and will work whether he must teach or not, but the quality and quantity of his work will be directly proportional to the time at his disposal. On the other hand, the investigator who is the product of educational methods is likely to accomplish less as the time at his disposal increases.

The character of the work differs in different cases. Some lines of work require longer absences or longer uninterrupted periods than others.

A man who has demonstrated his ability for research should be able to command a larger proportion of his time for this purpose as he approaches mental maturity.

A distinction should be made between elementary and advanced instruction. Class work with advanced students along lines in which the instructor is personally interested as an investigator is often a great aid to research because it permits contact with other minds, discussion, and the statement in words of thoughts. The mental stimulus involved in this relation between instructor and student is often of great value.

On the other hand, the routine of general or elementary courses, largely attended, where the element of personal contact is mostly absent, often interferes seriously with research.

As the investigator develops he should be more and more free from the routine work connected with instruction.

To sum up: The point of greatest importance is that the investigator should have extended periods of time free from other duties. These should be regarded not as vacation, but as a part of his work. Certain hours in the day or certain days in the week do not meet the needs of the investigator.

Another says:

My experience has convinced me that under the system commonly followed in our universities either the students suffer for lack of attention or research is neglected; and the more eminent the teacher the more surely is this the case. For as a teacher's reputation grows, so does the number of his students increase; and the eminent investigator is forced to either lock himself into his study and neglect his students or devote his days to instruction and restrict his researches to nights, Sundays and vacations, when mind and body are worn out. In no field is it more true than in this that a man can not serve two masters.

I believe that what may be termed the intensive system gives promise of affording relief to what is obviously a very undesirable situation. If the teacher will devote all of his energies for one half of the year to imparting instruction and directing the researches of his advanced students, the students will probably gain more, in most cases, than they do under the present system. And the conscientious teacher will be able to devote the other half year to research without being constantly oppressed with the feeling that he is neglecting students who have sacrificed much in order to gain the opportunity to study with him.

Under the intensive system it would doubtless require a somewhat larger corps of teachers to care for the students than under the present system, where nominally every teacher is available for instruction all of the time. But a professor working under the intensive system would do very much more than half the amount of instruction that he does under the present system; hence the necessary increase in teachers would be less than might appear at first sight.

A correspondent says:

I hold that it is the duty of the university to advance knowledge as well as to supply instruction. So far as possible professors should be permitted to do the work for which they are most competent. If a man is able to advance knowledge to an important extent—there are in fact not many such men—it seems to me that he should be required to give only so much instruction as would be fruitful for his research work. A professor can often do the most for his students by going on with his own work, thus imparting some of his spirit to them.

Another says:

I have always had definite convictions on this subject, which have come in part from personal inclination and in part from a remark you made to me during an impressionable period, in appreciation of a research man in a neighboring institution: 'He manages to use all of his time and energy for his own work.

In every institution there are men who glory in their large classes and the popularity that comes with them, and there are others who would be just as happy in their own work without any students—as long as their salary came regularly. I see nothing inherently wrong in the position of either one of the men, and see no reason why one should look on the other with disdain or the other on the one with envy.

Another says:

In my opinion professors engaged in productive research should meet with every encouragement and assistance from the university authorities. They should be amply provided with the books, the materials and the implements needed in research, and a reasonable portion of their working time should be set free for that purpose. What proportion should be thus set free may not admit of very definite statement, but it would seem that a well-endowed institution should so limit the scope of its work and the consequent amount of instruction offered that its productive scholars could apply at the least one half of their working time in advancing knowledge. It is my opinion that increase of knowledge considered by itself alone should be one of the definite aims of a university. But if this be not granted and the primary function of the university be considered the giving of instruction, it is just as essential that the professors should be investigators. Only those who are themselves engaged in research can lead students beyond the elementary phases of their subjects.

Another says:

I should say that it is at the present time much more important that the general principle of granting time for research be recognized by the universities than that any special fraction of such time be agreed upon. The complexities of the various factors entering in to the particular exigencies or particular cases would in any event make it extremely difficult to settle wisely upon such a fraction and I certainly have no fixed opinion as to the amount which ought to be thus assigned.

Where men are proved capable of profitable research and where institutions are able to make good the loss in the amount of instruction offered, I think a third of a man's time every other year could with great profit to the university be set aside for investigation. In some cases this time would be best invested if scattered over the whole year. In other cases it would be more efficiently spent if concentrated within some given period of three to six months. In certain unusual cases it is undoubtedly judicious to give a larger amount of time than this proposal provides for. Moreover, in some cases research can be carried on with entire success in connection with advanced class work, *e. g.*, certain forms of philological studies. In such instances there is obviously less propriety in setting aside special time for investigation. But as I said at the outset, these complexities are too numerous for me to attempt handling. It will be a great step forward if the principle of recognition of research as an integral part of a first-class instructor's duties can be gained.

Another says:

In general I may say that the instructor who does not investigate is exceedingly likely to get into ruts and will soon become a 'back number.' There is nothing like research to keep one posted on the work done by others. It is a constant incentive to reading. It keeps one posted not only in his special field, but from the interrelationship of problems, it gives him constantly an outlook over what is occurring in other lines.

To what extent the instructor should be relieved from instruction is another matter. If he be entirely relieved, the students of the institution receive practically no benefit from his researches, while he loses all influence over the student. In most cases to allow a professor to devote himself

entirely to research would be a violation of trust funds supporting his chair.

Certainly, in my opinion, every person connected with an educational institution should give some instruction, and I think it would be well if the heads of departments should have some hand in the teaching of at least one elementary class. It would tend to keep at least one foot on the earth.

A correspondent says:

There are many problems of research which require a great deal of time-consuming work in the preparation of material for the study. I believe they ought to have help in the nature of assistants to do a great deal of this kind of work in preparing the material for study and investigation. A professor of horticulture or agriculture is not required to plow his ground, cultivate and harvest his crops. He is given help to do this. He plans the research, oversees perhaps the preparation of the ground and the cultivation and the harvesting, but makes his study from the results of this manual labor which has been done by others. I believe similar help should be given to professors engaged in research in some of the lines of biological work.

Another says:

Regarding the relation of research to instruction, I feel very strongly that no instructor of upper classmen in a university should teach a subject if he has not come to know the values of its elements through testing some of them under new conditions. Even if the instructor be considered apart from his chosen field, simply as an instrument for the stimulation of the thinking power, he is not in a position to teach his subject unless he has some acquaintance with creative work. If I am correct in this view, it would be true that professors engaged in research have also a very important work to perform in instruction.

Another says:

I believe that at least half the time of every professor should be definitely set aside for research, provided said professor has shown the ability and energy to devote this time for such purpose. The enhanced reputation which professors engaged in research enjoy with their students, and the more comprehensive and critical value which it gives to their lectures and other forms of instruction, will more than compensate their institutions for the time set aside for this purpose. It is not men of routine, but men of original ideas, who are the most stimulating to students, and originality can only be generated and kept alive by research. Proof of this is found in the fact that the most inspiring teachers of all time have been investigators. Investigation can not be carried on with the brain fatigued by excessive teaching and excessive hours of administration. In many cases I believe the number of lectures and recitation hours could be substantially reduced with advantage both to the professors and to the students in institutions where owing to limited means a large corps can not be employed.

Another says:

An ideal research position, to my mind, would be one in which there was some teaching, but never enough to endanger the *continuity* of research.

Another says:

I should be very sorry to see our universities making any formal arrangements with their officers looking toward supporting them in research. In my judgment that would divert the universities from their own proper work and would give us a low grade of research. Hitherto research work has been the expression of the spontaneous interest and energy of the searcher, and I look with suspicion on any intrusion of the spirit of working for pay into this field. Yet I can see that in individual instances, where it is known that a man is engaged in an important research, it would be wise to relieve him of some portion of his other daily work. But I should hope such indulgence would never go to the point of making research the subject of contract.

Another says:

The scholarly men make the best teachers. I am not at all sure that the practise of teaching benefits the man of research. This would seem to be the case with the direction of the research of capable graduate students—but elementary teaching may be not only irrelevant to the scholarly interest, but distracting and fatiguing to the point of the exhaustion of energy and the atrophy of interest. I do feel, however, that the man of research is the safest person to whom to intrust the college student. Such a teacher is sure to win and to merit respect, for he measures himself by standards that are objective and intelligible to all.

The teacher who is not a scholar may be a winning and beneficent personality, but he is more likely to be a self-constituted oracle whose

dilettanteism is quite patent to the average undergraduate.

It seems to me clear that no educational system can afford to be dependent upon the chances of genius and temperament, even where these do slightly favor the unscholarly man. But as a matter of fact the chances seem to favor the scholar.

The great academic personalities seem, to my recollection, to have been men who enjoyed the dignity and the straightforwardness of scholars.

I believe therefore, that it is to the advantage of the university to have the same men discover and teach the truth. Professors should not be relieved of instruction, if this is to result in the specialization of the teaching function and the research function.

Furthermore, I do not see any possibility of fairly discriminating between individuals in this respect. The one or the other class (and under present conditions it is bound to be the teaching class, because of the recognition the scholar receives from outside) will be a degraded class, and this I should imagine to be fruitful of discord and jealousy.

I can not see that a moderate amount of instruction can interfere with a man's scholarship, and it is likely to afford him the sort of social service that he needs for his manhood.

I should suppose, then, that it would be wisest to make the required amount of instruction uniform and fix it at a moderate number of hours—say ten per week.

Still another says:

In many cases the complaints of professors that they have not sufficient time for research work, because of the undue amount of instructional work required of them, are not well founded, but are rather due to an inherent incapacity upon the part of the men to do effective research work, which they attribute to the large amount of teaching which they have to accomplish rather than to a natural dislike of hard work.

Another says:

Roughly stated, it is the function of a university to discover and disseminate truth, to train scholars, and to develop character. The relative stress laid upon these competing ends must vary with the conditions surrounding the institution, and in a specific case must be affected by the characteristics of the teacher, of his subject, and of his students, and also by the public opinion in the constituency of the institution and in its faculty and trustees. That public opinion seems to me to be adjusted into rough conformity with what average amount of instruction should be expected from the average teacher, and I should be disposed to regard this as the best basis available, to be deviated from in individual cases as circumstances might indicate.

In my own case, for example, I doubt that it would be wise for Cornell University to leave me more free from duties of instruction, with the deliberate purpose of letting me give more time to research. Such relief would make me less effective, I am convinced, as a teacher, and could be justified only if it was felt that my efficiency in research was greater than my efficiency as a teacher, or else that the need for research in my special field was greater. In some lines of work I believe it might be wise for the institution to provide a small group of junior appointees who might give all their time to research, and to allow ready transfer from the class of junior appointees whose main work was teaching to the class whose sole work was research, and the other way.

Another says:

I am strongly of the opinion that a university which is aiming at the highest ideals of university work should, when it finds men of real and proved capacity for original research of a high order, relieve them as far as possible of educational and administrative drudgery, though there can be no doubt that our universities probably could not afford to do this in the case of a very large number of their professors, nor perhaps would this be desirable. In point of fact, however, men of the type I have in mind are not numerous in any university. I believe that the activity of such men in a university brings in a very rich return through the atmosphere and example which it creates, and it seems to me that the best service of such men to their university lies in their own research work and that of the advanced students who come under their direction and influence.

I believe that such a man, for example, as Balfour did far more for his university in this way than through his lectures and other routine work, but I also think that to remove such men wholly from contact with the students would be a mistake from every point of view. My feeling is that such men should be relieved as far as possible from the drudgery of class work, elementary laboratory instruction, and above all, from administrative detail, for which they are very often unfitted by taste and temperament. I do not have in mind so much the time that is given to

these things, as the diversion of attention in directions wholly foreign to that in which their original work lies, and the destruction of that unconscious cerebration which is one of the most important factors in working out scientific results.

At the same time I fully recognize that a university is also a body of students that must be systematically taught, and I do not think that the work of the effective teacher should be considered as in any way inferior to that of the investigator, nor should professors whose first instinct is that of the teacher, be led to feel that their advancement depends on the accomplishment of original work.

You doubtless know better than I that investigation that is done under pressure of this kind is oftentimes a rather poor pretense. The tendency seems to me to be to differentiate these two types of university professors, and it is probably on the whole a good division of labor.

One thing seems to me quite certain, and that is that our universities will not attain their real aim until they are prepared to give full opportunities for research to men of the first type I have indicated. These are the men who form the real nucleus of the university, and their presence and labors seem to me of more importance from the point of view of real university work than all the rest of our educational machinery put together.

President Woodward, of the Carnegie Institution, says:

The way I put it to myself is this: Can we expect a college professor to do as good work of research for our institution as we might expect from him if he were taken over to the institution and had no work but that of research? Much experience convinces me that work of instruction is very valuable to a man who is pursuing investigation. On the other hand, I find that most men who are pursuing at once work of instruction and investigation in the colleges are giving only the smaller fraction of their time to investigation. Their first duty is toward the institutions with which they are connected, and any man who is efficient as an investigator is also likely to be efficient as an administrator and as a worker on the numerous committees essential to educational institutions. My personal experience and observation would seem to show that here again the work of investigation is commonly given second place.

On one point there is little or no room for doubt, namely, that the work of investigation done by professors and instructors in our American universities has only lately come to be justly appreciated, especially by trustees and regents.

From the point of view of an educational institution, there is likewise another point quite clear to me, namely, that no man can be an instructor of the highest grade without he is also simultaneously at work in some sort of research connected with his work of instruction.

Here I must close my quotations, resisting all temptation to continue. For in fifty other letters I find important considerations pithily stated. But as these all agree more or less distinctly with my own thesis, I must suppress them for the present on the principle adopted some ten centuries ago in burning the library at Alexandria.

SCIENTIFIC BOOKS.

The Dynamics of Living Matter. By JACQUES LOEB. (Columbia University Biological Series, VIII.) New York, The Columbia University Press. 1906. The Macmillan Company, agents.

This interesting book owes its origin to a series of eight lectures delivered by the author at Columbia University in the spring of 1902. The aim of the lectures was to give a presentation of the author's researches on the dynamics of living matter and the views to which they led him. In the present book, however, Loeb gives quite a complete survey of the modern problems of experimental biology, records a great many interesting facts and laws which were recently discovered in this field and discusses them from a broad point of view. The book still retains the division into lectures which are here extended to twelve.

The following quotations from the introductory remarks (lecture I.) inform us of the philosophical attitude of the author towards biological problems. "In these lectures," he says, "we shall consider living organisms as chemical machines, consisting essentially of colloidal material, which possess the peculiarities of automatically developing, preserving, and reproducing themselves." He

says further that we must admit "that nothing contradicts the possibility that the artificial producion of living matter may one day be accomplished. It is the purpose of these lectures to state to what extent we are able to control the phenomena of development, self-preservation and reproduction. * * * We shall only go far enough to satisfy ourselves that no variables are found in the chemical dynamics of living matter which can not be found also in the chemistry of inanimate nature."

In lecture II. the author deals with the general chemistry of life phenomena. Ferments and oxidation are the chief subjects of discussion. The idea of 'catalytic processes between tissues and liquids' was introduced by Berzelius, and Ostwald has shown that catalyzers do not initiate, but only accelerate reactions. The discovery by Crofton Hill and by Kastle and Loevenhart of the reversible action of enzymes is discussed; and also the observations by Neilsen of the reversibility of action by an inorganic catalyzer (platinum black) and that the effects of certain poisons are the same for both organic and inorganic catalyzers. Respiration as a catalytic process is considered. The possibility of two groups of oxidizing catalyzers is suggested: one, of the type of the peroxides, may be present in the protoplasm; and the second, which can act indefinitely as oxidases, may be found in the nucleus. Loeb calls attention to the fact that oxygen not only supplies potential and kinetic energies, but is also important for cell division and growth, and acts as 'protective' agent. Lack of oxygen causes structural changes. Experiments which show the production of CO_2 by enzymes are reported. Concerning the theory of enzyme action Loeb gives a brief statement of the attempt in the stereochemical direction; but he is rather inclined to accept the theory of intermediary reaction. Everything seems to indicate that enzymes form unstable combinations with the bodies whose reactions they accelerate.

In lecture III. under the head of the general physical constitution of living matter are discussed: the limits of divisibility of living matter; Bütschli's views that living protoplasm has the structure of a microscopic emulsion; the colloidal character of living matter; the formation of semipermeable membranes. Loeb gives here the Meyer-Overton theory of anesthesia with which he does not fully agree. "The rapidity of the absorption of narcotics may be due to their solubility in oil, and yet the effect they produce may be due to something entirely different." With regard to the rôle of osmotic pressure and the exchange of liquids between the cell and the surrounding liquid, to the discussion of which a few pages are devoted, it may be mentioned that Loeb says he now believes 'that contractile phenomena inside the cell furnish at least part of the energy of secretion and absorption in those cases where the osmotic forces alone can not explain these phenomena.' In the same lecture an account is given of Loeb's extensive experiments on the antagonistic effects of salts.

In lecture IV. some physical phenomena of life are discussed: the theories of muscular contraction, of protoplasmic motion, of cell division; the origin of radiant energy (phosphorescence) and the electrical phenomena in living organisms.

Lecture V. is on the rôle of electrolytes in the formation and preservation of living matter. Loeb gives here among other things a condensed but clear account of the very extensive and important studies by himself and his pupils on ion-proteid compounds and their relations to contractile tissues. The articles dealing with these subjects are very numerous and scattered in many publications, not all of which are easily accessible. The knowledge of these articles is quite indispensable for a student in general physiology. It is gratifying, therefore, to have an authoritative account of the entire subject presented in only thirty pages.

Lecture VI. deals with the effects of heat and radiant energy upon living matter.

Lectures VII. and VIII. are devoted to a discussion of the different tropisms, to the knowledge of which in the animal world the author has, as is well known, contributed pioneer work.

In lecture IX., on fertilization, the reader will find among other things a lucid account

of the experiments which led up to and established the epoch-making discovery of artificial parthenogenesis.

In lecture X., on heredity, the following subjects are discussed: the hereditary effects of the spermatozoon and eggs; Mendel's important experiments; the mutation theory of de Vries; the determination of sex; the relation of egg structure to heredity; the observations and experiments of Driesch and E. B. Wilson. It does not seem to Loeb 'that a discussion as to the relative influence of protoplasm and nucleus upon heredity will prove very fertile, but that it is necessary to transfer this problem as soon as possible from the field of histology to that of chemistry or physical chemistry.'

Lecture XI. is on regeneration. Here again the author has done a good deal of original investigation and in some parts, as on heteromorphosis and on the influence of the central nervous system, Loeb has done pioneer work. He discusses the subject from the point of view of Sachs's hypothesis of the formation of organs. Loeb here refers the reader to Morgan's writings on regeneration.

In his concluding remarks (lecture XII.) Loeb says among other things: "There is, therefore, no reason to predict that abiogenesis is impossible, and I believe that it can only help science if the younger investigators realize that experimental abiogenesis is the goal of biology. On the other hand, * * * it is not sufficient for this purpose to make proteins synthetically, or to produce in gelatine or other colloidal material round granules which have an external resemblance to living cells."

It is a very interesting book which instructs and at the same time stimulates the reader to independent thinking.

S. J. MELTZER.

ROCKEFELLER INSTITUTE.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for July contains but two articles, 'Adaptive Modifications of Occipital Condyles in Mammalia,' by Charles S. Mead, and 'Living and Fossil Species of Comptonia,' by Edward W. Berry. The former notes the general adaptations of the condyles to permit the movement of the head, the special modifications for carnivorous habits and the arrangement of the condyles in different orders. The second paper is an attempt to work out the relations of such forms as may be referred to *Comptonia,* discusses the succession of forms and includes descriptions of the species admitted by the writer, with their synonymy.

The Museums Journal of Great Britain for June has 'Some Notes on a recent Trip to Greece and the Greek Islands,' by Robert F. Martin, an article on 'National Art Patriotism,' dealing with the purchase of a 'Venus and Cupid' ascribed to Velasquez for £45,000, secured for the National Gallery through the National Art Collections Fund, and an account of the 'New Natural History Museum for Salford.' The organization of the American Museum Association is noticed, and it should be said that the Museums Association of Great Britain cabled its best wishes for the successful inauguration and future progress of the sister society. There is a very considerable instalment of the British Museums Directory, which includes such national institutions as the British Museum, Victoria and Albert Museum and others.

THE leading article in the *Journal of Nervous and Mental Disease* for July is a paper by Dr. Waldemar Heinrich Groszmann on 'The Position of the Atypical Child.' Dr. Groszmann defines his terms very carefully, giving in tabular form a survey of the entire range of child variation. He emphasizes the fact that the atypical condition is a transitive one and tends to become permanent either in the direction of abnormality or of some degree of typicality. He finds it impossible to educate successfully such children in the ordinary public and private schools in conjunction with home environment, and believes that the solution of the problem lies in the institution where the environment can be controlled and adapted to the end in view. Dr. Archibald Church reports a case illustrating the neuritic type of progressive muscular atrophy with a marked heredity, and a second on syringomyelia with involvement of cranial nerves,

probably a syringobulbia. Both these papers are illustrated. Dr. Hugh T. Patrick publishes a brief supplementary report and correction to his paper on 'Hereditary Cerebellar Ataxia' in the March issue of the *Journal* for the year 1902. The meeting of the Boston Society of Psychiatry and Neurology for January 19, 1906, and that of the Chicago Neurological Society for November 23, 1905, are reported.

THE first three numbers of the *Philippine Journal of Science* contain several papers which will not appear elsewhere. Among these may be mentioned the completed series on the cocoanut, its growth, the production of oil from the nuts, and the insects attacking the trees, by Messrs. Copeland, Walker and Banks; the monograph on tropical ulcers and the paper on plague vaccination, by Dr. Strong; the preliminary discussion of beriberi, by Dr. Herzog; the first of a series treating of the geology of the Philippine Islands, by W. D. Smith, etc. There have also been published the results of the investigations carried on in Manila by Drs. Brinkerhoff and Tyzzer, but these latter have also been given to the public elsewhere in somewhat different form. The fourth number of the *Journal* will contain the first of a series of articles on the composition of a tropical forest, by H. N. Whitford, the subject being taken up from an ecological standpoint; and the fifth, the beginning of a number of papers on Philippine fibers and fiber substances, with especial reference to their availability for paper making, by George F. Richmond. In June there will also be published seven of the papers read at the third annual meeting of the Philippine Islands Medical Association, one of these being by Professor Kitasato, of Tokyo, on combating plague in Japan, another by Professor Shiga on bacillary dysentery, one by Dr. Strong on questions relating to the aggressins, one by Dr. Stitt on dengue fever, one by Dr. Craig on malaria, and a monograph by Dr. Musgrave on amœbic dysentery and its complications, the subject of liver abscess being especially discussed by the latter.

DISCUSSION AND CORRESPONDENCE.

APPEAL FOR AN AERO-PHYSICAL OBSERVATORY IN JAPAN.

IT is well known that the progress of meteorology has seemed very slow. Within the past century the world has seen electricity, chemistry and other special branches of science emerge from their previous uncertain and indefinite condition, but dynamic meteorology is still wandering in fog and darkness. Thousands upon thousands of observations at the earth's surface have told us much, but still the fundamental mechanical problems have not yet been solved. Although the importance of the exploration of the upper atmosphere has been recognized ever since the days of Pascal, yet very little is known of this vast mysterious ocean of air. Meteorologists are now fully convinced that the atmospheric phenomena at the earth's surface depend, in great measure, upon the thermal and electrical, as well as the dynamic, conditions of the upper atmosphere. So long as this upper region remains unexplored, meteorology will not only be unable to enter into the group of exact sciences, but will fail to do its full service for the promotion of human welfare. Hence, a number of mountain observatories have been established in Europe and elsewhere, and many balloon and kite ascensions have been made for sounding the depths of the upper atmosphere. The balloon ascensions of Gay Lussac and Biot in 1804, of Barral and Bex in 1850, of Glaisher in 1862, and of Berson in 1894, furnished many important facts relative to the physics of the atmosphere. Since this last date, unmanned balloons, carrying only very light self-registering apparatus, have been brought to great perfection, and extreme heights of eleven or twelve miles have been reached that would otherwise have been inaccessible. By this mode of research Hermite, Besançon and Teisserenc de Bort in France, and Assmann, Berson and Hergesell in Germany, have done a great service to meteorology. Beginning with October, 1902, daily balloon and kite ascensions were made by Assmann and his associates at the Prussian Aeronautic Observatory, while Teisserenc de

Bort's great work in his famous observatory at Trappes, near Paris, dates back to 1890.

The kite experiments in atmospheric electricity made in America by Benjamin Franklin in 1753, and by Joseph Henry in 1840, are now classic. Most important contributions to meteorology by kite-flying have been made by Messrs. Rotch, Fergusson and Clayton, of Blue Hill Observatory. The United States Weather Bureau in 1898 temporarily maintained seventeen kite stations, and is now completing the Mount Weather Research Observatory, where the temperature, moisture and movement of the air at great heights will be ascertained by means of balloons and kites, while other researches on the sun's heat, atmospheric absorption, atmospheric electricity, terrestrial magnetism and seismic phenomena will be conducted.

In Japan, too, the importance of study of the upper air was recognized soon after the organization of our meteorological service in 1875. Since that time the specialists at the Central Meteorological Observatory at Tokyo and at provincial stations have undertaken many technical expeditions to high mountains in order to investigate the phenomena of the higher strata of the atmosphere. For the establishment of the first Japanese mountain observatory we are indebted to our illustrious Prince Yamashina. For the site of this observatory his imperial highness chose Mount Tsukuba, that remarkable mountain which stands alone on an extensive plain, and which, moreover, lies in the tracks of the cyclones of very intense character. Since its opening in 1902 it has been of great service to observational meteorology in Japan.

It is evident, however, that the atmospheric data observed at mountain stations are very much affected by the local topography and the disturbing elements of the mountain mass and surface. A consideration of the observations made in the free upper air during balloon ascents from Munich, and those made simultaneously at neighboring mountain stations, shows important differences between them. Hence it becomes vitally important for each civilized country or nation to establish on its own soil an aero-physical observatory, like those at Trappes, Blue Hill, Berlin, Lindenberg and Mount Weather.

The scientific problems to be investigated at such a research observatory are manifold, and include the following:

1. The distribution of temperature in the upper atmosphere; the thermal conditions in cyclones and anticyclones; the distribution and condensation of atmospheric moisture; the distribution of pressure in the upper and the lower atmospheres. These are problems of paramount importance, and must be investigated by ascensions of balloons and kites.

2. The absorption of solar heat by the atmosphere, which must be measured by means of the pyrheliometer and actinometer; the dissipation of solar light and heat as determined by the polariscope; the detailed analysis of the sunbeams as carried out by means of the bolometer and spectrometer. To all these there should be added apparatus for studying the conductivity and emissivity of the land and water, the snow fields and the forests of the earth's surface.

3. The discovery of the remarkable properties of radium has opened up a field of research relative to the ionization of gases, and this has led to a complete revolution in our ideas relative to atmospheric electricity. By means of an Exner's electrometer and Benndorf's self-registering apparatus the potential should be measured. To make systematic observations of dissipation and radioactivity of the air under ground we need the Elster and Geitel instruments. Corresponding measurements of the ionization should be made with the Ebert ion-counter, and the Gerdien conductivity apparatus.

Japan feels the direct influences of the Pacific Ocean and the Asiatic continent, and also those of the tropical and polar ocean currents, so that meteorological as well as climatic conditions in Japan are very complex. Very often a continental cyclone, which appears to originate in the Asiatic continent, and a typhoon, which comes from the tropics by way of the Philippines and Formosa, pass over Japan simultaneously, bringing great complexities in the weather. In spite of all these difficulties, however, the storm tracks

and other meteorological conditions have been very carefully investigated by eminent Japanese meteorologists. Japan has just established a new weather service in Korea and Manchuria, and is said to be intending to extend the service to southern China. These are all for immediate practical daily forecasts; but the exploration of the free upper atmosphere by balloons and kites has not been touched. This vast upper ocean of atmosphere, the study of which is exceedingly important for further advances in the physics of the atmosphere, as well as in the prediction of the weather, must remain entirely unknown to Japanese meteorologists until they are able to investigate it.

Japanese meteorologists do not generally possess all the expensive instruments and apparatus that are found in the United States and Europe. In the whole of Japan there is probably not a complete set of modern apparatus for the study of atmospheric electricity, such as those of Elster and Geitel, Ebert, Benndorf or Gerdien. Japanese physicists and meteorologists have relied on their own hands and brains, but we have now come to the age when international cooperation in science is progressing rapidly and our scientists should be provided with laboratories and observatories containing powerful instruments and apparatus. It is sad, indeed, to hear from Japanese meteorologists that they have no hope of establishing an aero-physical observatory similar to those mentioned above.

I have been asked if I can induce some worthy American patron of science or some institution to establish an aero-physical observatory in Japan, or somewhere on the other side of the globe. What we should want at first would not necessarily be a great observatory, such as Mount Weather, but a small one, or several such, where we can observe with kites the conditions of the upper atmosphere, and can also study the atmospheric electrical phenomena by using the Ebert, Elster and Geitel and Benndorf apparatus. Such work is entirely new in Japan, but good physical assistants and materials can be obtained at small cost. It will require comparatively a small sum of money to establish and maintain such an observatory in Japan.

All Americans remember gratefully that the Smithsonian Institution, of Washington, which has done wonderful service for the increase and diffusion of scientific knowledge in America, was founded by a foreigner, an Englishman, James Smithson, in the beginning of the nineteenth century. May not Japan receive similar encouragement from foreign countries or institutions? Scientific research is becoming more and more international and cooperative; it soars far above the differences of race and national policy. The results of the meteorological investigations that are carried on in an aero-physical observatory in Japan will be directly beneficial to the whole human race as well as to that country. The world's meteorology will receive far greater benefits indirectly than will Japan directly. Our atmosphere must be studied as a unit. When the atmospheric conditions in the upper and the lower strata become thoroughly known over America, Europe and Asia, then, and only then, can meteorologists establish the true theories of cyclones, anticyclones, floods and droughts on a firm observational basis. We must remember, however, that at present the atmospheric conditions in the upper atmosphere over the eastern hemisphere of the globe are entirely unknown, and the final solution of our complex aero-physical and dynamical problem is still far away.

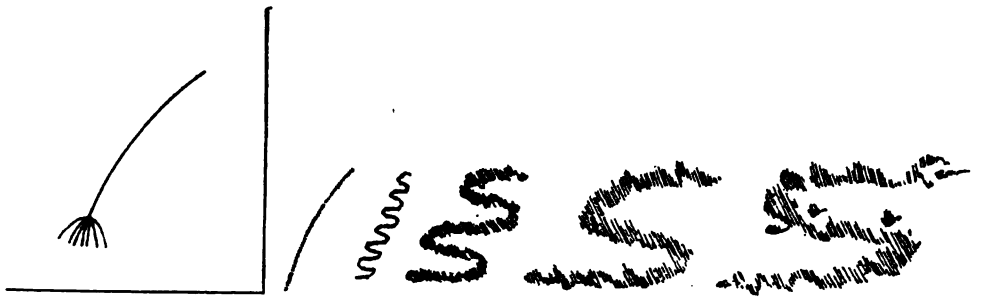
All nations send their naval and merchant vessels to Japanese ports, where we do our best to forewarn them of dangerous storms. A storm-warning service blesses all nations alike. Its signals represent an international cooperation for the benefit of all mankind.

For these reasons I appeal confidently to the American patrons of science for the funds necessary to establish a modern aero-physical observatory in Japan.

S. T. Tamura.

AN UNUSUAL METEOR.

To the Editor of Science: The recent descent of a meteor and its resultant impressed me as being so unusual and interesting that I am prompted to write about it.



At 5:30 P.M., October 13, 1905, shortly after leaving Cortland, N. Y., on a Lehigh Valley train for Elmira, N. Y., I observed to the south or southwest a meteor of great brilliancy. Its first appearance was about thirty degrees from the zenith and descended very rapidly in an arc to about the same distance from the horizon, when it burst like a sky-rocket. It left a narrow, smoky trail, which gradually increased in size and changed in form to a zigzag, becoming more cloud-like in appearance and growing fainter and fainter until it was entirely dissipated. The smoky trail in its transition was distinctly visible for ten minutes. The sketches indicate its gradual transition.

E. E. DAVIS.

NORWICH, N. Y.

SPECIAL ARTICLES.

ON THE OCCURRENCE OF DESMOSTYLUS, MARSH.

THE genus *Desmostylus* was described by Marsh[1] in 1888 from tooth fragments found in Alameda County, California. It was referred to the Sirenia, and its nearest affinities were supposed to be with *Metaxytherium* from the Tertiary of Europe. In 1899 and 1900 additional specimens were examined by the writer, with a view to obtaining further information as to its affinities, but no material was obtained which furnished more evidence than the type specimens described by Marsh.

In 1902 Yoshiwara and Iwasiki[2] described from the Miocene of Japan a number of specimens showing tooth structure almost identical with that of *Desmostylus*. This material also furnished considerable evidence concerning the structure of the skull. The authors recognized the resemblances of this form to the Sirenia.

Shortly after the appearance of the paper on the Japanese specimens a review of this article was published by Professor H. F. Osborn,[3] who included a short note on recent studies of *Desmostylus* by Merriam. Professor Osborn considered the reference of the animal somewhat uncertain, very properly pointing out that both sirenian and proboscidean characters were represented.

During the past year two occurrences of *Desmostylus* have come to the notice of the writer. In both cases the reference of the specimens to this form seemed beyond question, and in both instances the occurrence furnished evidence of considerable importance regarding the possible habitat of the animals. The first specimen, consisting of two well-preserved columns of a large *Desmostylus* tooth, came into my hands through the kindness of Professor Andrew C. Lawson. It was obtained by Professor Lawson from Mr. W. L. Still, of La Panza, San Luis Obispo County, Calif. It was found in a cultivated field on Mr. Still's ranch. This locality is stated by Professor Lawson to be in a belt of Monterey shale which extends through this part of the country for many miles.

The second lot of material, including numerous tooth fragments, was presented to the university by Mr. C. H. McCharles, of the University of California. It was obtained from a belt of shale six miles northeast of Santa Ana, Orange County, California, and

[1] *Am. Jour. Sci.*, 1888, p. 94.

[2] *Jour. of the Coll. of Science*, Imperial Univ. of Tokyo, Vol. 16, Art. 6, 1902.

[3] SCIENCE, N. S., Vol. XVI., p. 713.

was found in association with a large number of shark teeth.

In both instances the strata in which the *Desmostylus* remains occur are typical marine deposits, evidently of Miocene age. The fauna of these formations is in the main that of the open sea rather than of the shore, and it is difficult to conceive of proboscideans as occurring typically in these beds. The presumptive evidence, therefore, points pretty definitely toward an aquatic type as the one from which these remains have come.

Of the previously described American specimens we have known very little concerning the occurrence. The only one of which we have any definite information is in the collection of Professor Thomas Condon, of the University of Oregon, who informed me that it was 'picked up on the Yaquina beach, which is throughout marine.' Marsh states that the type specimen was found associated with the remains of a mastodon, a camel, a large edentate, and one or more species of horse, apparently indicating that the deposits were of alluvial or fresh-water origin. Unfortunately, there is no record to indicate exactly where or under what circumstances the material was obtained. The occurrence of the other three specimens from California is also very uncertain.

Influenced by the statement of Marsh, the writer inclined originally to the view that *Desmostylus* was obtained in fresh-water deposits. At the present moment, the only definite evidence fails to lend support to this view. In the case of the Japanese material the evidence is of much the same character as that now available here. It was associated with the teeth of the shark, *Carcharias japonicus*, and with the marine shell *Solen*. Impressions of some land plants were also found, and the authors expressed the view that the deposits, though marine, were of shallow-water origin. Possibly the range extends from marine beds through estuary deposits in both America and Japan.

Although the above notes do not give us very satisfactory information as to the habitat of *Desmostylus*, such evidence as is now before us indicates that this form is an aquatic animal and, therefore, probably a sirenian rather than a proboscidean. If *Desmostylus* were a typical proboscidean distributed from Japan to southern California, one would expect to find it ranging some distance inland on both continents. While its non-appearance inland might be due to our having overlooked it in collecting, its appearance in the marginal marine deposits on both sides of the Pacific suggests that its wide range was over the sea.

John C. Merriam.

QUOTATIONS.

THE FACULTIES IN AMERICAN UNIVERSITIES.

In discussing a paper by Professor Andrew F. West, of Princeton University, presented at the seventh annual conference of the Association of American Universities, President Van Hise, of the University of Wisconsin, said:

I believe that unity in a university is more important than administrative efficiency, and just so sure as the president and deans and councils are made superior to the faculty the university will lose unity. Indeed, to control general university policies, I believe in a single university faculty which includes every member of the instructional force, so far as participation in debate is concerned, with every person of professorial rank as voting members. To that faculty the various administrative committees should be accountable, and while they may have full power in carrying out settled policies, important variations of policy should be reviewed by the faculty. This proposal of course does not interfere with the power of the faculties of the several colleges to control their own affairs. It seems to me it would be a profound mistake for the president to depend upon his own initiative. If he is not in close fellowship with his faculty, so that they freely come to him with their best suggestions, the institution will make educational progress very slowly indeed. It has been my privilege to receive suggestions freely from the Wisconsin faculty. For my own part, I would sooner see a measure in which I believe not passed, than to have it passed over the faculty. If I can not present the advantages of the measure so that it appeals to their reason, then, in all probability, I am wrong in my educational policy. It may be that in some cases the faculty may be wrong; educational progress might have gone a little faster, had the faculty been overruled; but the grand

average will be much better by the thorough co-operation and harmonious relations which come from mutual respect and mutual acceptance of one another's ideas.

Possibly a president ought to have appeal to a corporation over the faculty. An emergency might arise in which this power might be necessary; but a president will be very wise to use that power rarely. I never have used it, and it would be an extreme case in which I should do so. If a measure were adopted by the faculty of which I thoroughly disapproved, which I could not carry before the trustees with my recommendation, I should ask the faculty to appoint a committee to present that subject to the trustees, so that the faculty should have full representation of their view. I might be obliged to dissent from that view, and then the trustees must exercise their final responsibility.

In conclusion, I think it is important that all the members of the instructional force shall know why a thing is done. If there is a senate above the men, and that senate takes the initiative and passes acts which have been opposed by the faculty as a whole, there is dissension; if, on the other hand, everybody has been given opportunity to express his views fully, then every man feels: "I had my opportunity to express what I had to say; the faculty has voted so and so; that stands as the university action and I will support it." I may be in a somewhat extreme position in regard to this matter; I would have not only perfect liberty upon the part of all our members of a faculty, but I would have unity and concentration of power in a single faculty for general educational policies.

PROFESSOR HENRY A. WARD.

WITHIN a little more than a year two great students of meteorites have passed away. Professor E. Cohen, of Greifswald, who died on April 13, 1905, made studies of the structure and composition of the iron meteorites which marked an important advance in our knowledge of these bodies, and his writings on meteorites in general were monumental in character. Professor Henry A. Ward, who died on July 4, 1906, was the world's greatest collector of meteorites, and made also important contributions to the science of the subject. Both left projected plans incomplete. Professor Cohen's 'Meteoritenkunde' was purposed to be a work of six volumes, of which only three were completed at the time of his death. Professor Ward had practically completed a last great collection, but he had in preparation a large work in three volumes descriptive of the collection and covering the subject of meteorites in general, which was only partially finished. Aside from his work as a collector Professor Ward had made important contributions to our knowledge of meteorites which will always be of value. Perhaps his greatest service, and one which he rendered as no other could, was that of visiting remote corners of the earth to obtain exact and complete knowledge of meteorites whose existence had been hitherto only partially verified. His latest work of this kind was perhaps one of the most important. This was a trip to Santa Rosa, United States of Colombia, to gain exact knowledge regarding an iron meteorite concerning which little was known since the mention of it in 1824 by Boussingault. This trip he had long had in mind and had partially undertaken at other times, but he had not been successful in carrying out his purpose until the present year. He obtained about 300 pounds of this meteorite and full information regarding both it and the adjoining meteorite of Rasgata, which had been much confused with it in literature. It is to be hoped that his notes regarding this meteorite are sufficiently preserved so that a record will be saved to science. Other important meteorites which he 'rescued' in a similar manner were those of Bacubirito in Mexico and Veramin in Persia. The acquisition of the latter meteorite required a visit to the Shah himself, for which Professor Ward's native address and diplomacy served him in good stead. For tasks of this character Professor Ward was fitted as few others ever have been, for his wide knowledge of the world in a geographic sense enabled him to penetrate to the remotest regions and secure exact information. The meteorite catalogues which he has published from time to time have also been peculiarly useful in the accuracy of the locations given, since this accuracy came from a personal knowledge of localities on the part of Professor Ward. This is a service to science which was especially needed, since the

localities of meteorites are an important feature in the determination of their relations, and much confusion has often been caused by efforts to determine whether differently named meteorites belong to single falls. Professor Ward's catalogues will long remain probably the best authority in these matters. Of his last great collection of meteorites, it is enough to say that it contains representatives of more falls than any other collection in the world, and its weight compares well with the largest. The collection thus is, as he desired it should be, the crowning achievement of his life in this direction, and other collectors can bear witness to the fact that he left little ungathered.

Aside from his contributions to science, Professor Ward will long be remembered for his charming personality. The writer's acquaintance with Professor Ward was confined to the later years of his life, but it was a privilege which he highly esteemed. As a *raconteur* Professor Ward had few equals. His many years of travel, his native humor, shrewdness and business sense gave him a wealth of observation and philosophy from which to draw tales that were of the most delightful and instructive character. A letter from Professor Ward, too, was always a delight. Few ever combined more humor and philosophy, shrewdness and science in a single epistle than Professor Ward was accustomed to do, and it is to be hoped that some collection of these writings of his may be made. Professor Ward's knowledge of languages, obtained through years of travel, greatly facilitated his work as a collector. He gained a knowledge of French in his early years through study in Paris, and later travel acquainted him with German, Spanish and several other languages. His knowledge of Spanish was sufficient on a recent visit to Chile to enable him to lecture in that language on the subject of meteorites to the students of the School of Mines in Santiago.

Professor Ward also rendered great service to science in his earlier years through the Natural Science Establishment which he founded. His work in this regard was epochal in creating and developing an interest in natural history museums in this country. The value of the educational influences which he thus set in motion can only be seen in part as yet. While this work bore a more or less commercial aspect, this was by no means Professor Ward's only interest in it, and that he was able throughout his life to serve the cause of pure science was a source of satisfaction to him and fortunate for the world.

Oliver C. Farrington.

FRITZ SCHAUDINN.

The untimely death of Dr. Fritz Schaudinn, at Hamburg on June 22, removes from service one of the most brilliant of the younger generation of biologists, and one who, by careful and conscientious work, has made a name for himself that will endure. Neither an old nor a young man, Schaudinn has, before the age of thirty-five years, done more solid and lasting work of a pioneer nature than any other of his generation, and so wide has been his range of activity that he will be equally missed in the fields of general biology, cytology, zoology and pathology.

Schaudinn's work has been mainly on the unicellular organisms, the protozoa, although he did not confine his investigations to this field. We find his name, for example, in connection with strictly zoological work on Tasdigrades of the Arctic region, and *Ankylostoma* in the mining regions of Westphalia. In another direction we find him bringing his keen observation and power of experimentation to bear upon the problem of bacteria structure, while in general executive work his energy was given to editorial duties in connection with *Das Tierreich* and the *Archiv für Protistenkunde,* of which he was the originator and sole editor.

In the field of pathology Schaudinn has become the foremost and final authority on the disease-causing protozoa. Beginning with the discovery of *Leydenia gemmipara* in the ascites fluid of patients suffering with malignant tumors, he has been one of the most careful and at the same time the most brilliant investigators in this most difficult field of re-

search, and it is not too much to say that Schaudinn's name has been connected with every distinct advance that has been made in protozoan pathology. In his work at the Kaiserlichen Gesundheitsamte on various forms of human disease his experiments were most ingenious and well conceived, while his interpretations were a happy combination of liberality of view and judicious conservatism. While at this post he carried out experiments showing the specific differences between the harmless *Entamœba* (*Amœba*) *coli* and the pernicious *Entamœba histolytica*, the cause of amœbic dysentery. In connection with this institution also, but at the Rovigno Laboratory, he worked out the full life history of *Plasmodium vivax*, the cause of tertian fever, and put the last missing link in the chain of evidence connecting the mosquito with malaria, by watching the penetration of human blood corpuscles by sporozoites taken directly from the mosquito's salivary gland. It was from this laboratory also that he brought out his much-discussed life history of *Trypanosoma noctuæ*, which gave the first light on these important organisms which are so bound up with human affairs in the nagana and surra, etc., of Africa and India, and Trypanosomiasis and sleeping sickness in man. It was while connected with the Berlin institution that he made his last important discovery of *Treponema pallidum*, the cause of syphilis, an organism that has been sought for in vain by biologists and pathologists since the germ theory of disease was established.

It was in the field of general biology, however, that Schaudinn's greatest and most far-reaching work was done. The problems connected with reduction, and maturation in general, and of parthenogenesis, have been illumined by his researches on the life history of protozoa. He was the first to give a complete account of the life history of protozoan organisms, and his work on *Coccidium schubergi* is a model of completeness of detail and of scientific presentation. With it came the stimulus for renewed and more careful observation on protozoa all over the world. With this conception of the life cycle always in mind and its importance in protozoan study always prominent, he studied many different types of protozoa, and in whatever direction he turned the science of protozoology was advanced. The life activities of *Calcituba*, of *Actinophrys*, *Sphærastrum*, *Acanthocystis*, *Paramœba*, were worked out, and the full life histories of *Entamœba*, *Centropyxis*, *Hyalopus*, *Polystomella*, *Trypanosoma noctuæ*, *Spirochæta ziemanni* and *Plasmodium vivax* were established.

In his writings Schaudinn was simple and direct. Nothing was stated for effect, and there is an absolute lack of the polemical spirit in his work, which bears only the fair interpretation of his own work with never a thought of priority or of personal advertisement. His experimental work was conceived and executed with a rare combination of skill and patience, and in its very simplicity of statement his writing had the merit of carrying conviction, so that what he has done will remain as landmarks in the field of protozoan research.

GARY N. CALKINS.

THE ROYAL BOTANIC SOCIETY OF LONDON.[1]

THE great revival in gardening which has been taking place during the last few years has not had such a beneficent effect on the Royal Botanic as on other kindred societies. Instead of increasing its membership by leaps and bounds and thus improving its financial position, it has found expansion impossible and new enterprise checked by lack of funds. The question as to whether any of the conditions in its constitution and methods are at fault has been under discussion for some months. A committee of conference of fellows was appointed and a report (or rather two, as there was a minority one also) has been presented to the council suggesting various possible reforms. These have been under the consideration of the council, who have just issued their reply. It is evident that, although there is willingness to meet the fellows' wishes on several points, none of the sweeping changes advocated will be adopted; and it seems doubtful to those outside the society who are competent to judge whether the few changes will

[1] The London *Times*.

be sufficient to meet the present difficulties. The idea of admitting a certain number of fellows without the payment of entrance fees has not been accepted, on the ground that 350 would have to be elected to bring in the same sum as 100 who paid the entrance fee. So this apparently simple inducement to get new members is to be put aside. Whether they continue to join at all with the five guineas entrance and two guineas annual subscription remains to be seen. It is clear, however, that the same sum will give more privileges in most horticultural societies. It has been suggested that the transactions of the society should be brought out in a more pretentious form, and the council certainly seems wise in rejecting this proposal at present, which is only likely to increase the expenses of the society without adequate compensation. Whether the plan of admitting nurserymen to the gardens and giving them space for growing the plants they offer for sale is the best way of insuring an improvement in the gardens may be open to question, but there is much to be said for the plan; and the plots need not occupy all the available space: anyhow this, too, is rejected. But no alternative alteration is contemplated by the council, who appeal to the opinion of four trustworthy experts, who have reported on the condition of the gardens. From the point of view of good gardeners they have no fault to find; the upkeep of both the open ground and the greenhouses reflects credit on the staff.

But what strikes the outsider is that in this age of progress in horticulture, when people are constantly getting new ideas and studying fresh combinations, there are no opportunities to learn at the botanic gardens. There is nothing to stimulate, nothing to inspire. The gardens are not better than the park outside; so the inducements to become a fellow are few, although the club-room and library are a valuable addition. Even at the shows many people feel there will not be so much that is novel, and the keenest horticulturists do not go, and the nurserymen, who admit that they are given every facility, and that every consideration is shown them, and they have more room for display, yet take far fewer orders in three days there than they do in one elsewhere. The fact is, the gardens, although charming in many ways, are not up to date, and complacent satisfaction in their present fitness will not mend matters.

It is strange also that lectures should not have been well attended. Those given on botanical subjects at the Chelsea Physic Garden, which is not in a much more central position, had an average attendance of seventy, which shows there is room for work in this direction.

It will be a great loss to science if this important society, once the leading one, forfeits its high position by not pursuing a more forward policy at this critical moment in its history.

THE INTERNATIONAL INSTITUTE OF SOCIOLOGY.

The Institut International de Sociologie was organized in 1893, with headquarters in Paris, where its congresses have hitherto been held. Its first president was Lord Avebury, the present president of the Sociological Society. From the beginning, its international character has been maintained. Its membership has included Professors Kovalewsky and Novicow for Russia; Brentano, Bücher, Conrad, Schmoller, Schaeffle, Simmel and Wagner for Germany; Gumplowicz and Menger for Austria; Baldwin, Giddings, Small and Ward for America; and, besides Lord Avebury, Professors Foxwell, Nicholson, Tylor, Sidgwick and Mr. Frederic Harrison for Great Britain.

The present congress came to London through the joint invitation of the Sociological Society and the University of London. All of the sessions were held in the Jehanghir Hall of the University Building, South Kensington.

After the closing meeting, excursions to Oxford and Cambridge took place, which, it was hoped, could be arranged as motor car excursions. A visit to Edinburgh and Glasgow was planned to take place some time during the week following the congress.

The provisional program was as follows:

Tuesday, July 3, at 4 P.M.—General opening meeting. Addresses by the president of the institute, the president of the Sociological Society, and a representative of the University of London. Report of the secretary-general.

8:30 P.M.—Conversazione given by the University of London.

Wednesday, July 4, at 10:30 A.M.—'Caractères généraux des luttes sociales': M. J. Novicow, Professor Lester Ward, Professor Ludwig Gumplowicz, Dr. Raoul de la Grasserie, M. S. Halpérine.

3:30 P.M.—Garden party given by Lord Avebury.

Thursday, July 5, at 10:30 A.M.—Suite du débat.—'Les luttes sociales d'après Herbert Spencer': Professor Ludwig Stein. 'La guerre est-elle un facteur nécessaire?': Professor A. D. Xénopol.

2.30 P.M.—'Luttes sociales dérivées des problèmes industriels en Angleterre': M. Frederic Harrison. 'La lutte pour le travail, et les inemployés': Professor Loch. 'Etude comparée des luttes sociales contemporaines dans les principaux pays occidentaux, y compris l'Amérique du Nord': Dr. Emil Reich.

8 P.M.—Banquet given by the Sociological Society.

Friday, July 6, at 10:30 A.M.—'La sociologie des partis politiques': Professor Lester Ward. 'L'évolution politique de l'Italie': Senator Professor G. Arcoleo. 'La foule et les meneurs': M. K. J. Kochanowski. 'Les luttes intermentales': M. Emile Frey.

2:30 P.M.—Closing meeting.

RESULTS OF THE GERMAN CENSUS.

THE results of the German census, which was taken on December 1, last, represent the total population of the home empire as 60,605,183 persons, an increase of over 47 per cent. since 1871, and of 7.52 per cent. since the census of 1900. A study of the distribution of the increase among the various parts of the empire shows that Prussia, with nearly two thirds (37,278,820) of the total population, has grown at a greater rate than the rest of Germany, the increase in the number of its inhabitants during the past five years being 8.14 per cent. Growth has been most rapid in the three western provinces in the valley of the middle Rhine—Westphalia (13.50 per cent.), Rhineland (11.74 per cent.), and Hesse-Nassau (9.07 per cent.)—which, with an area of less than one fifth of that of Prussia, contains nearly one third (12,124,052) of its population. In the county (Regierungs-Bezirke) of Potsdam there has been an exceptionally rapid increase in the population the number of inhabitants being returned as 2,327,853, or 20.66 per cent. more than in 1900. The city of Berlin, the population of which is enumerated separately, had last December 2,040,222 inhabitants, an increase of 8.01 per cent. In no province or county of Prussia was there a decline in the population during the intercensal period, but the growth in the eastern provinces, occupying the sandy North German plain, was below both the average for Prussia and the average for the German Empire. In the province of East Prussia the rate of increase was only 1.46 per cent. (in the previous five years, however, a decline had been registered); in the province of West Prussia it was 5.01 per cent., in the county of Frankfurt (Brandenburg) 1.93 per cent., in the province of Pomerania 3.02 per cent., and in Posen, Silesia, and Prussian Saxony between 5 and 6 per cent. In Hanover the rate of increase rose again to 6.52 per cent., while in German Jutland (Schleswig-Holstein) it exceeded the average, being 8.38 per cent. Outside of Prussia the population of the two great southern kingdoms, Bavaria and Würtemburg, comprising much of the southwestern highlands as well as the alpine foreland of Germany, rose by 5.45 and 6.03 per cent., respectively, and amounted last December to 8,813,154, while the already densely populated kingdom of Saxony, with 4,502,350 inhabitants, had increased its population by 7.14 per cent. In the Grand Duchy of Baden (2,009,320 inhabitants), bordering the right bank of the upper Rhine, the rate of increase was precisely that of the German Empire—7.52 per cent., while in Hesse and Oldenburg it reached 8.14 and 9.77 per cent., respectively, furnishing another instance of the rapidity with which the population is increasing in western and northwestern Germany. Among the small states bunched together in the highlands of Central Germany, the rate of increase was compara-

tively small—mostly 3, 4 and 5 per cent. It is noticeable that in Alsace-Lorraine, the population of which declined from 1871 to 1885, there has been since the latter date a progressive increase in population, the percentage of growth during the past five years being 5.53 and the actual population last December 1,814,626, or 265,000 more than in 1871. The continued tendency of population to accumulate in large cities is illustrated by the returns for the Hanse towns, the increase in the case of Hamburg (free city and state) being 13.89 per cent., in the case of Bremen 17.14 per cent., and in the case of Lübeck 9.38 per cent. The male population of Germany (29,868,096) is still slightly less than the female population (30,737,087); but, taking the empire as a whole, the proportional increase in the former (7.68 per cent.) has been slightly in excess of the increase in the latter (7.36 per cent.).

SCIENTIFIC NOTES AND NEWS.

Professor Seubert, hitherto the German member of the international committee on atomic weights, has resigned, and Professor Ostwald has been appointed his successor. The committee now consists of F. W. Clarke, United States, chairman; T. E. Thorpe, Great Britain; H. Moissan, France, and W. Ostwald, Germany.

Mrs. W. P. Fleming, curator of astronomical photographs in the Harvard College Observatory, has been elected an honorary member of the Royal Astronomical Society. Mrs. Fleming has also been appointed honorary fellow in the department of astronomy in Wellesley College, in recognition of her distinguished work in astronomy and in gratitude for her helpful cooperation in the establishment of astronomical work in Wellesley College.

Dr. Ch. Wardell Stiles, of the Public Health and Marine Hospital Service, has been elected correspondant étranger of the Société Centrale de Médecine Veterinaire de France.

Professor Edmund Weiss, professor of astronomy in the University of Vienna, has been elected a corresponding member of the Paris Academy of Sciences in the room of the late O. Struve.

Dr. A. Weismann, professor of zoology at Freiburg, celebrated, on July 9, the fiftieth anniversary of his doctorate.

Dr. Adolf Wüllner, professor of physics at Aachen, has celebrated his seventieth birthday.

Professor Conway MacMillan has resigned the chair of botany at the University of Minnesota, and will, it is understood, go into business.

Mr. Edward A. Fath, instructor in astronomy in the University of Illinois, has been appointed fellow in the Lick Observatory.

According to a press despatch from Washington, the commission appointed by the Secretary of the Treasury, the Secretary of Commerce and Labor and the Secretary of Agriculture to formulate rules and regulations for the enforcement of the pure food law, held its first meeting on July 23 at the Department of Agriculture. Dr. H. W. Wiley, chemist of the Department of Agriculture, was elected president, and James L. Gerry, chief of the divisions of customs of the treasury, secretary. It was decided to begin work immediately upon the regulations, and the committee will meet from time to time for consultation as opportunities will be presented. Public hearings will be held, beginning in New York City, on September 17.

A number of his old pupils have indicated their intention to join in the presentation of his portrait to Sir Henry Littlejohn, emeritus professor of forensic medicine in the University of Edinburgh.

The Cambridge Philosophical Society has awarded the Hopkins prize for the period 1897–1900 to Mr. S. S. Hough, F.R.S., chief assistant at the Royal Observatory, Cape of Good Hope, for his work on the dynamical theory of the tides.

The London Chemical Society has awarded its Longstaff medal to Professor W. N. Hartley for his spectroscopical researches.

The Ceylon government has added a hospital to the pathological laboratory which it recently established at Colombo. Both institutions are under the charge of Dr. Castellani.

The states of Maryland and North Carolina will cooperate this summer with the U. S.

Geological Survey in the investigation of the geology of the Atlantic Coastal Plain formations. This work will be done under the direction of Professor W. B. Clark, of the Maryland State Survey.

THE geology of the Wilmington, Phœnixville and Honey Brook quadrangles in southeastern Pennsylvania will be mapped this summer by Miss Florence Bascom, assistant geologist of the U. S. Geological Survey and associate professor in Bryn Mawr College. She will complete the survey of the crystallines of the Wilmington and Phœnixville quadrangles and make a preliminary survey of the Honey Brook quadrangle, with a view to gaining further light on the problem of the Piedmont gneisses.

AREAL and economic surveys in Georgia, North Carolina, South Carolina and Tennessee will be made this summer by Mr. Arthur Keith, geologist, of the U. S. Geological Survey, assisted by Mr. D. B. Sterrett.

MR. WILLIAM L. FINLEY met with a somewhat serious accident by the fall of his horse while he was engaged in photographing bald eagle and osprey nests on San Clamente Island.

MR. E. G. WOODRUFF, instructor in mineralogy at the Oklahoma State University, has been granted a year's leave of absence to study at Harvard, where he has secured a scholarship.

MR. JOHN G. HALL, assistant in the Harvard department of botany, has been elected to the position of assistant in plant pathology in the North Carolina Agricultural Experiment Station.

AT the general meeting of the British Institute of Hygiene, held last week, Sir William Broadbent was elected president and Sir William Bennett, Surgeon-General Cleghorn, Sir Alfred Cooper, Mr. Mayo Robinson and Professor Sims Woodhead were elected as vice-presidents of the association.

DR. PAUL DRUDE, who last year went to Berlin as professor of physics and director of the physical laboratory, died by suicide on July 5, at the age of forty-two years. Dr. Drude was editor of the *Annalen der Physik* and was eminent for his theoretical and experimental researches on the electromagnetic theory of light.

THE death is announced of Dr. Joseph Körösy, director of the Statistical Bureau at Buda Pesth and the author of important studies on demography.

THE death is announced of Dr. George W. Atherton, since 1882 president of the Pennsylvania State College. He was born in Massachusetts in 1837, and graduated from Yale University in 1863.

THE U. S. Civil Service Commission announces an examination, on August 29–30, to secure eligibles from which to make certification to fill at least ten vacancies in the position of assistant engineer, at salaries of $1,400 to $1,600 per annum and two or more at a salary of $1,800 per annum each, in the Philippine Service, and similar vacancies as they may occur in that service.

THE French Association for the Advancement of Science is holding its thirty-fifth meeting at Lyons this week, under the presidency of M. Gabriel Lippmann.

AN International Congress on Polar Exploration will meet at Brussels, beginning on September 7. Further information may be obtained from M. Lecointe, director of the Brussels Observatory.

THE International Committee on Aeronautics, of which M. Hergesell is president, will hold its fifth biennial congress at Milan at the beginning of September. M. Palazzo, director of the Italian Meteorological Service, will be the president of the congress.

THE seventh annual meeting of the American Conference of Pharmaceutical Faculties will meet at Indianapolis, Ind., on September 5 at 3 P.M., under the presidency of Dr. Henry M. Whelpley, of St. Louis.

BY action of the legislature of Indiana, the Indiana University has been given the management of the Donaldson farm, a tract of one hundred and eighty-two acres of timber land, on which are the openings to extensive caves and to the richest blind-fish localities

known. For the full year from September 1, 1906, to September 1, 1907, the university offers a fellowship to the value of $500 to a graduate student desiring and able to conduct research work with cave animals. He must reside on the farm. The university has erected a two-roomed shack, 15 x 30 feet, which serves temporarily as sleeping quarters and laboratory. The place is equipped with beds, kitchen and dining-room furniture, aquaria, microscope, etc. Applications and letters of enquiry should be addressed to C. H. Eigenmann, Winona Lake, Indiana.

UNIVERSITY AND EDUCATIONAL NEWS.

The sum of $50,000 has been given to Yale University by Mr. Edwin Milner, of Plainfield, Conn. The interest on the money is to be used to educate some resident of Plainfield.

The State College of Physicians and Surgeons of Indianapolis, Indiana, has entered into an affiliation for educational purposes with Indiana University. By terms of the affiliation the first two years of the state college will be given in the laboratories of Indiana University, in the medical department of which the first two years of medicine have been given for several years. The last two years of the course will be given at Indianapolis, where a new hospital with a capacity of one hundred beds has been organized under the direct control of the state college, which will be used for clinical teaching. This will make it possible for students to follow cases throughout the entire course of the disease and assist in after-treatment of surgical cases. Graduates of the school will receive their medical degree and diploma from Indiana University.

King Edward has approved the appointment of a Royal Commission for the purpose of holding an enquiry into Trinity College, Dublin, and the University of Dublin. The commission will consist of Sir Edward Fry (chairman), the Chief Baron of the Exchequer, Ireland, Sir T. Raleigh, Sir A. W. Rücker, Dr. H. Jackson, Dr. Douglas Hyde, Professor D. J. Coffey and Mr. S. B. Kelleher.

The following promotions and appointments have been made at Brown University: Associate Professor Alexander Meiklejohn, dean of the university, to become professor of logic and metaphysics; Assistant Professor W. H. Kenerson, to become associate professor of mechanical engineering; Assistant Professor A. H. Blanchard, to become associate professor of civil engineering; Assistant Professor H. P. Manning, to become associate professor of mathematics; T. M. Phetteplace, to become assistant professor of mechanical engineering; C. W. Brown, to become assistant professor of geology; F. S. Beattie, to become assistant in chemistry; M. L. Dolt, to become assistant in chemistry; H. E. Chandler, to become assistant in civil engineering; and Miss Alice W. Wilcox, to become instructor in biology and household economics at the Women's College.

At Lehigh University the following nominations and appointments have been announced: P. A. Lambert and Arthur E. Meake have been advanced from assistant professorships to full professorships in mathematics; John H. Ogburn from an instructorship to an assistant professorship in mathematics and astronomy; John Duer Irving from an assistant professorship to a full professorship in geology; Barry MacNutt from an instructorship to an assistant professorship in physics.

Mr. E. B. Hart, associate chemist of the New York Agricultural Experiment Station, has been chosen professor of agricultural chemistry and chemist of the Experiment Station of the University of Wisconsin.

Mr. Chas T. Kirk, A.M. (Oklahoma, '05), was recently elected assistant professor of geology at the Montana School of Mines, Butte, Montana.

The Alice Freeman Palmer fellowship at Wellesley College has been awarded to Miss Anna Johnson, B.A. (South Dakota), M.S. (Iowa), A.M. and Ph.D. (Radcliffe), a student in mathematics.

Dr. Max Le Blanc, professor of physical chemistry at Karlsruhe, has been called to the chair at Leipzig, vacant by the retirement of Professor Wilhelm Ostwald.

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THE NATURE AND ORIGIN OF VOLCANIC HEAT.

THE hypothesis of a molten or more or less fluid interior, as possessed by the earth, may now be said to have been abandoned, and along with it the supposition that volcanoes constitute vents for the escape, as a consequence of shrinkage and subsidence, of a portion of the molten content lying everywhere under the solid crust. The hypothesis that the interior of the earth, while in the main solid, has cavities containing melted matter which occasionally is forced out in the form of eruptive outbursts is a kindred one which has found some adherents. But a truly solid interior seems to be demanded by the accepted great rigidity of the body of the earth, and Mallet has put forward the idea that extraordinary pressures exerted to crush the rocks would result in their becoming heated and melted. Evidently, however, mere pressure acting alone, however great, would not suffice for this. Incipient fluidity would substantially put an end to the crushing process and heat generation would stop. The observed high temperatures attained by volcanic products during eruption would not be reached. More recently the thermal effects of volcanoes, and the various results thereof, have been ascribed by one authority to the presence of radium, which, as is known, continuously gives out energy in its breaking up. But volcanic lavas have not been found to be sources of radium or of uranium, the amount of which should be

quite large if the supposition is to be given any serious consideration.

The object of this paper is to present a view of the origin of volcanic heat which may possess some elements of novelty and, it is hoped, of rationality. According to this view, much of the heat manifested is due to mechanical work converted into heat, a theory based upon dynamical principles to be later pointed out. Primarily it will be admitted that any substance, gas, liquid or solid, upon which work is done acquires heat in proportion to the energy expended upon it, which heat, if prevented from escaping, at once results in an increase of temperature of the substance. If the mechanical energy so converted be of known amount, we may calculate from the mass and specific heat of the substance or body upon which such energy is expended the rise in temperature. Even if air at ordinary temperature under high pressure escapes through a tortuous or frictional passage surrounded by a good heat non-conductor, it emerges hot. The higher the pressure and the greater the friction met in the passage the greater the increase. The heating is directly related to the work done upon the mass.

If a liquid be substituted for the air the general result is the same, and the liquid may be made to boil upon its escape. If a somewhat plastic solid like hard pitch be subjected to the process, the energy required will be greatly increased, or the pressure required to force it through the tortuous passage of some length will be great. It may emerge hot and melted if the conditions be properly selected.

If now it be assumed that any solid be subjected to a pressure such as to cause it to flow in a tortuous or restricted channel, it will, in so moving, rise in temperature, and continue so to rise until it has reached a degree of fluidity such as to lessen or practically stop the absorption of energy in moving the mass; or until it escapes from the passage through which it is being impelled. The pressure is but one factor of the energy, the other being the distance through which the pressure acts. The pressure required depends upon the resistance to motion, which in turn is greater with more rigid bodies and greater with increase of distance through which friction is met and overcome. The pressure or force required will be at a maximum when the solid mass starts cold or nearly so and will diminish as the temperature is raised and consequent plasticity or fluidity brought about. A rock mass forced to move under great pressure over distances of thousands of feet must soon become melted in the process. It is not necessary to assume that the mass so heated starts cold. It may start at any temperature at which it possesses sufficient rigidity or viscosity to require the exertion of great force to move it in the assumed restricted or tortuous passage or channel. Great velocity of movement in such passage means of course great energy expenditure and rapid heating. The idea thus outlined may now be applied as an explanation of volcanic phenomena. For example, a hot-water spring may be the result of the water having been forced by high pressure to traverse somewhat porous rock, or to pass through narrow but long fissures in which it is churned for a long time before escaping. In like manner any rock mass which, subjected to very high pressure, begins to flow must become heated. If its distance of traverse be great enough in a restricted fissure or channel, it must melt, or even become so heated as to partially vaporize when the pressure is relieved, as when it finally escapes. Let it be admitted that the flexures taking place in the earth's crust or in the outer portions of its mass

may bring to bear upon deep-seated and perhaps already heated solid rock masses a sufficient pressure to cause them to readjust their positions, and the condition demanded by the theory is present. Such a condition would mean movement of such masses over considerable distances at high pressures, with the final result of the formation of molten streams ready to escape upward from the pressure exerted upon them. A vent would at last form and the rush of the partially melted rocks towards and out of this vent would become a lava flow. These actions would naturally occur at places of flexure such as would tend to form a ridge, and the loading and sinking of sea bottoms as a consequence of sedimentary deposits would be favorable, as is well known, to such flexure as would tend to heavily compress the rocks along the line of flexure deep down from the earth's surface, while relieving or not increasing pressure near the surface. The compressed rock would in general tend to be shifted or made to flow outward at the line of flexure. This view accords well with the facts. Volcanoes exist along lines more or less parallel to or adjacent to sea coasts or along the weak lines in the earth's surface. It will easily be seen that a single volcanic vent or pipe may serve to relieve or provide a point for outflow for the shifting of material over a great length of flexure deep down under the earth's surface. As the flow and fusion would be a somewhat gradual process it may well be that only when the vent is about to open will there be earthquakes and great subterranean noises, more or less local to the place of outbreak. Very probably eruptions in which melted lava does not appear to have a part, but in which steam and gases, sand, or mud are ejected, are nevertheless dependent upon an upthrust of lava or a subterranean lava stream, which never reaches the surface, but the temperature of which is such that, on its reaching hydrous rock strata, the water is evolved as steam at high pressure, which entering superincumbent layers gives rise to mud eruptions, or escapes from vents or fumaroles.

It would be expected that such rock masses as, under pressure, would yield most readily would be the ones to flow and form lavas. They would also be likely to be the more readily fusible masses, assuming that before the process of compression and extrusion begins they exist at a temperature more or less elevated above that at the surface of the earth. The locus of the rock flow might, therefore, be in deep regions several miles down, so deep indeed that relief of pressure could not occur by folding of upper layers or strata, which would involve the bodily uplift of rocks above, which rocks, exerting an enormous downward pressure, may be of great relative rigidity.

The view of the origin of volcanic heat here advanced makes the paroxysmal nature of volcanic eruptions almost a necessity of the case. The rocks would resist an accumulation of pressure tending to cause them to flow, but finally, under continued increase of force, they would begin to readjust themselves. This would result in heating, softening and fusion. A vent might form and thus on account of the fluidity of the moving mass the accumulated pressure would for the time be relieved. But the original causes might still exist and continue, even after cooling of the heated material in the vents, to result in pressure accumulation, renewed flow and fresh outbreaks at periods more or less remote. The final decay of volcanic action in any region would result from such a permanent readjustment of strains as to entirely relieve the rock masses of any pres-

sures which could become critical and cause flow.

During the cooling of a globe of heated and partly fused matter, such as the earth and moon are believed to have once been, the early volcanic outbursts on them would be without violence, and it seems likely that the materials ejected would have temperatures not greatly above that of the surrounding masses. An eruption at that time would be a welling up of great bodies of rather quiescent lava derived at once from the fluid contents below a but slightly cooled surface. As the further cooling made the body more solid and rigid, especially at the outside surface, the mechanical energy spent in causing an eruption would lead to higher temperatures of erupted matter, which would escape with more violence, explosions of vapor or gas would occur, partly due to vapors evolved from the melted masses upon relief of pressure at the vent, and partly the result of contact of the hot lavas with colder surrounding rocks containing gases or water. Ashes and cinders would become a feature of the eruption. At still later stages eruptions would become less frequent and vents less numerous, but the violence of the outbursts would increase, owing to the very high temperatures reached by the extruded matter during the journey towards expulsion.

It may seem somewhat paradoxical to hold that as a body, such as is the moon, cooled, the temperature of the ejected volcanic matter would rise, but in the present view this would be a consequence of the necessary exertion of greater pressures to cause eruption, owing to the enormous amount of mechanical work or energy expended, as the matter would be forced from greater depths. It happens that upon the earth much of the evidence of volcanic action in archaic or early geological times has been obliterated by erosion and sedimentation, but we have in the moon's surface a record which is not so modified or defaced.

From the whitish streaks surrounding such craters as Tycho Brahe and Copernicus, a type of crater not very numerous on the moon, which streaks are most conspicuous at the time of full moon, it is seen that there have been effects of eruptions of these great craters which extend over hundreds of miles from the craters. These whitish streaks are superimposed upon, and therefore later than, many of the other craters and markings over which they spread. These streaks are probably the depositions from condensed vapors which left the craters in almost radial lines. Inasmuch as the moon has very little atmosphere even at its lower surface and much less at the heights from which these vapors escaped in leaving the craters, the straight line or radial direction taken by them is not surprising; in fact, it is necessary. Vaporous matter escaping into a vacuum moves in precisely that way. Had the earth no atmosphere, the ashes and vapors from a volcanic crater would move away from it in just the same manner, and would be scattered in radial streaks from the notches in the crater walls and to enormous distances. If again the surface of the moon, as seems likely owing to absence of water, be covered with loose masses, or be broken instead of smooth, or be covered with pieces of rock of varying size, it is easy to understand why these whitish streaks should require for visibility a high angle of solar illumination. The condensed deposits would fall in between the boulders or stones on the surface and at low solar elevations would be in the shade or shadow of the broken pieces on the surface. That the surface of the moon, in large part, may be covered with fragments of rock, boulders and stones is probable from the great part that volcanic ac-

tion has played in giving configuration to its surface, and the absence of any influences which would alter the aspect or general make-up of the surface outside of volcanic disturbances. The markings alluded to as existing around such craters as Tycho and Copernicus, as well as the great depth and other marked characteristics of these and similar craters, declare them to be the more recent of the great volcanic outbursts on the lunar surface. They bear the impress of having been very violent, and the vapors indicate ejections hot up to the point of vaporization. If the view presented is correct, this is entirely natural. On the other hand, contrast these craters with those called Archimedes and Plato, lava plains, surrounding which we see no vapor or fume streaks, and no evidence of great violence, and we are brought to infer that these latter are the results of more ancient action in the nature of more gentle welling up from below of fused matter, not so greatly heated by the energy of expulsion. Such craters are shallow and were probably more in the nature of quiescent pools or lakes of lava than great relief vents from great depths traversed by materials at high velocity and at the high temperatures brought about by the process of superheating while moving against resistance in volcanic pipes. So far then as the moon furnishes evidence on this subject it may well repay further study, and its condition seems to confirm the position taken herein. It has sometimes been claimed that much of the explosive effect of gas and steam from volcanoes may be due to water entering or percolating through heated strata and being converted into steam at enormous pressures. But the possibility of this is doubted. The very pressure of vapor would stop the process at its outset. No water would enter a hot stratum unless forced in by a pressure in excess of that which the steam would acquire upon its generation. A boiler can not be fed with water by a pump which yields less pressure than that carried by the boiler itself.

If, however, the water be already present in a rock stratum which is invaded by hot lava rising in a volcanic fissure, then its conversion into steam and the violent emission thereof may readily take place.

It is conceivable too that considerable movement or shifting under pressure of any moist stratum over considerable distances, especially through a restricted channel, may result in heating it to a temperature sufficient to generate steam. Here again, as in the case of the rock flow before referred to, the work done in moving the particles against great resistance may under proper conditions cause an accumulation of heat energy sufficient to account for explosive effects when the material reaches a vent. Under such conditions also, the expulsion of hot mud or sand with steam may occur without the concurrence of lava flow.

The considerations herein put forward seem to furnish a basis for a dynamical theory of volcanoes. Doubtless the action of heating a flowing rock by energy expended upon it may be, and perhaps is, often supplemented by other causes, such as chemical action brought about by hot contact of substances having affinity for each other. Gaseous products under high pressures may be the consequence of the reactions. Limestone or other carbonate may be decomposed by the contact of hot lava, and carbonic acid gas in great volumes be thus liberated.

We certainly have no need of recourse to an assumption of the existence of large localized bodies and radium minerals to explain volcanic action. To say the least such an assumed store of this rare element is improbable.

The view here advanced, it is thought, presents far less difficulty. It is indeed an extension of Mallet's idea to include other factors of energy besides pressure.

The fact that the heated volcanic masses are in the earth, surrounded by materials of low heat-conducting power, makes the accumulation or retention of heat energy generated by mechanical work possible. The local character, as well as the varied nature of volcanic phenomena, is not difficult to understand. Volcanic outbursts must continue so long as readjustments of the positions of rock masses under a critical condition of pressure occur with the deeper surface layers.

If, as appears probable, the earth's interior is metallic iron, surmounted by a covering of oxidized lighter material, slag-like in character but altered by water and sedimentation, etc., the interior temperature or that of the metallic body is not likely to be very high, and it must be fairly uniform in spite of the gradual increase noted in the surface rocks at increasing depths. Such surface rocks or layers, being of relatively low heat conductivity, serve, so to speak, as a non-conducting blanket in which alone a considerable temperature gradient would be manifested. This condition does not forbid the possibility of the readjustments of masses herein regarded as the initial cause of superheating, even if those masses be quite hot but under such gravitational pressure of superincumbent masses as to forbid fusion.

ELIHU THOMSON.

THE GEOGRAPHICAL DISTRIBUTION OF THE STUDENT BODY AT A NUMBER OF EASTERN AND WESTERN UNIVERSITIES AND EASTERN COLLEGES.

THE accompanying table explains the geographical distribution of the student body of six of the leading universities of the east and of four western institutions, as well as of three New England and two Pennsylvania colleges for the academic year 1905–06, summer session students being in every instance omitted. It was impossible to secure accurate figures for the academic year just closed in the case of the *University of California,* and consequently the figures for 1904–05 were substituted. Comparing the attendance by divisions of the six eastern universities (*Columbia, Cornell, Harvard, Pennsylvania, Princeton, Yale*) with the corresponding figures for the same universities included in a similar table published in SCIENCE, N. S. Vol. XXII., No. 562 (October 6, 1905), pp. 425–6, we note in the first place that there has been a gain for these universities taken as a whole in every division, the largest increase in actual number of students, leaving the north Atlantic division—in which all of these six universities are located—out of consideration, having been recorded in foreign countries, where there has been a gain of eighty-seven students, this being as large as the entire increase of the student clientele of these universities in the United States divisions (exclusive of the north Atlantic). In the south Atlantic states and in the insular possessions these eastern universities have made only a slight gain; in the south central division all of them show an increase with the exception of *Princeton;* in the north central division the chief gains have been made by *Columbia, Princeton* and *Yale,* in the western division by *Columbia, Pennsylvania* and *Yale,* and in foreign countries by *Columbia, Cornell* and *Harvard.* These figures bear out the statement made by the writer in earlier contributions to SCIENCE to the effect that the western and southern clientele of the prominent eastern universities is not suffering any shrinkage. At *Columbia* the attendance from outside

RESIDENCES OF STUDENTS
(A) UNITED STATES

1905-1906	Amherst	California	Columbia	Cornell	Dartmouth	Harvard	Illinois	Lafayette	Lehigh	Michigan	Pennsylvania	Princeton	Williams	Wisconsin	Yale
North Atlantic Division.	**387**	**9**	**3486**	**2517**	**879**	**3494**	**26**	**324**	**509**	**490**	**2517**	**955**	**348**	**89**	**2289**
Connecticut	24		73	46	22	58		2	5	5	38	15	17		1057
Maine	3		20	13	44	116	1			9	11	3	6		28
Massachusetts	196	4	78	78	418	2383	5	1	11	18	60	24	95	5	188
New Hampshire	1		7	7	243	70			1	5	14	2	4	2	12
New Jersey	12	2	407	143	8	68	1	65	52	13	207	277	29	5	112
New York	110	3	2774	1911	54	501	12	23	47	248	130	272	173	14	608
Pennsylvania	24		95	301	6	169	6	233	392	175	2046	357	14	11	188
Rhode Island	8		11	10	6	99			1	5	7	2	1	1	25
Vermont	9		21	8	78	30	1			12	4	3	9	1	21
South Atlantic Division.	**11**	**8**	**112**	**180**	**7**	**110**	**16**	**11**	**99**	**40**	**152**	**95**	**8**	**15**	**98**
Delaware			1	9		1		3	3		32	5			13
District of Columbia	4	2	6	53	5	38	3	5	19	12	22	17	2	6	27
Florida	1		6	2		4	2			4	7	3			7
Georgia			22	12		9	3			5	8	3		3	7
Maryland	5	1	16	47	1	18	1	3	60	2	38	45	1	3	10
North Carolina			19	11		8	3		1	3	8	6		1	9
South Carolina	1		15	7	1	11	2		1	1	5	3		1	9
Virginia			20	30		13	2		10	8	16	8			10
West Virginia			7	9		8			5	5	16	5		1	6
South Central Division.	**5**	**8**	**75**	**80**	**8**	**92**	**47**		**15**	**63**	**64**	**63**	**2**	**8**	**89**
Alabama	1		14	16		9	1		1	3	13	6			7
Arkansas			5	7		8	5			7	4	4		3	1
Indian Territory			1	2			3			2		2		1	1
Kentucky	2		17	13	1	36	7		4	24	25	23	1		30
Louisiana			6	5		11	6			1	2	1			6
Mississippi		1	7	7		2	6		1	1	3	5			4
Oklahoma			1	1		6	2			10	1			1	4
Tennessee	1		10	12	1	9	4		9	3	2	9		2	14
Texas	1	2	14	17	1	11	13			12	14	13	1	1	22
North Central Division	**43**	**37**	**287**	**380**	**91**	**487**	**3299**	**9**	**6**	**3380**	**189**	**219**	**86**	**3120**	**586**
Illinois	10	8	28	121	54	106	2872	4	1	313	16	59	31	193	147
Indiana	1	1	40	28	1	39	75			163	13	24	8	24	26
Iowa	2	9	10	20	3	42	93	1		88	13	20	6	71	34
Kansas		3	13	7	1	15	21		1	34	8	4	1		18
Michigan	5	4	33	22	2	28	31	1	2	2275	8	13	3	11	37
Minnesota		2	27	9	1	30	24	2		26	9	10	8	30	45
Missouri	16	3	32	24	8	42	34			67	8	22	1	16	58
Nebraska	1	1	13	6	3	13	18			18	1	4	2	4	7
North Dakota		1	3	1		4	4			9	1			9	
Ohio	6	2	63	128	14	137	31	1	2	341	54	45	18	16	135
South Dakota		1	3	1	2	2	15			11	2	2		15	5
Wisconsin	2	2	22	13	2	29	81			35	6	16	8	2731	24
Western Division	**7**	**3202**	**117**	**75**	**15**	**124**	**47**	**2**	**1**	**149**	**37**	**31**	**5**	**25**	**98**
Arizona		3	4			1	2			3				1	1
California	1	3093	30	18	1	45	5			25	7	6	1	4	21
Colorado	3	7	19	19	12	28	13			41	8	10	1	11	33
Idaho		2	2	3		2	4			4	3				1
Montana		5	14	4		9	6			25	1	6		3	3
Nevada		5	3			1									1
New Mexico		7	1		1	4	1			7	1			2	
Oregon	1	35	9	11		11	5	1	1	7	2	4	1	3	13
Utah		7	25	10		11	4	1		16	3	3			7
Washington	2	38	8	8	1	11	7			14	12	1	1	1	11
Wyoming			2	2		1				7		1	1		2
Insular Possessions		**14**	**6**	**23**		**12**	**12**	**1**	**4**	**11**	**5**	**1**	**1**	**9**	**8**
Hawaiian Islands		9	3	5		9	1			1	1		1		6
Philippine Islands		5		12			10	1		5	2			8	1
Puerto Rico			3	6		3	1		4	5	2	1		1	1
Total	**453**	**3268**	**4063**	**3255**	**995**	**4319**	**3447**	**347**	**634**	**4133**	**2914**	**1364**	**445**	**3216**	**3063**

the north Atlantic division has increased from 15.07 per cent. to 17.65 per cent. during the last four years.

Taking the UNIVERSITIES in the accompanying table by divisions, we find that *Harvard* and *Columbia* have the largest representations in the north Atlantic division, *Cornell* and *Pennsylvania, Yale* and *Princeton* following in the order named. *Michigan's* representation has increased from 394 to 490 in one year, the other western (the term as thus used includes the north central and western divisions) universities—*California, Illinois, Wisconsin*—attracting only a few students from this section of the country. *Harvard* leads in all of the New England states with the exception of Connecticut, where *Yale* of course has the largest clientele. *Columbia* and *Cornell* naturally have the largest representation in New York state, *Yale, Harvard, Princeton* and *Michigan* following in the order named, as they did last year. *Michigan's* increase in this state—from 195 to 248—is noteworthy. In *New Jersey* the order is also identical with that of last year, namely, *Columbia, Princeton, Pennsylvania, Cornell, Yale, Harvard.* The *University of Pennsylvania* naturally leads in its own state, followed by *Princeton, Cornell, Yale, Harvard, Columbia.* Examining the attendance at the COLLEGES from these states, we note that the order for the entire division is *Dartmouth, Lehigh, Amherst, Williams, Lafayette. Dartmouth* leads the colleges in Maine and Massachusetts—*Harvard* being the only one of the universities having a larger following in these states than the New England college in question—as it does in New Hampshire and Vermont, where its following is far in excess of that of any other college or university represented in the table. Only a few students from Rhode Island attend the colleges included in the table, the students from this state being attracted in largest number to *Brown* and *Harvard.* In Connecticut the order is *Amherst, Dartmouth, Williams,* all of the eastern universities except *Princeton* having a larger representation in this state than any of the New England colleges here included. *Lafayette* and *Lehigh* have no following to speak of in any of the New England states, although they are well represented in New Jersey and New York. In the states just mentioned the order of the New England colleges is *Williams, Amherst, Dartmouth,* all three exceeding the two Pennsylvania colleges in New York and being surpassed by them in New Jersey. Of the eastern universities *Pennsylvania* has the largest percentage of enrolment from its own state, namely, 67 per cent.; of *Columbia's* student body 66 per cent. come from New York state, of *Cornell's* 56 per cent. hail from the same state, of *Harvard's* 54 per cent. are residents of Massachusetts, of *Yale's* 33 per cent. have their permanent residence in Connecticut, and finally, of *Princeton's* students only 20 per cent. are residents of the state of New Jersey. *Princeton* and *Yale* are thus the only two of the eastern universities mentioned which attract more than half of their students from outside the states in which they are respectively located. Of the three New England colleges here included, 21 per cent. of the student enrolment of *Williams* hail from Massachusetts, 24 per cent. of *Dartmouth's* student body come from New Hampshire (32 per cent. from New Hampshire and Vermont), and 43 per cent. of *Amherst's* students have their permanent home in Massachusetts. All of these colleges therefore attract the larger percentage of their student body from outside of the states in which they are respectively located, while in the case of *Lafayette* and *Lehigh* the reverse is true,

the percentage of Pennsylvania residents being 67 per cent. in the case of *Lafayette* and 60 per cent. in the case of *Lehigh*. It is also interesting to observe that *Dartmouth* draws more students from Massachusetts than it does from New Hampshire, that *Princeton* draws more students from Pennsylvania than from New Jersey, and that *Williams* attracts more from New York than from Massachusetts.

Coming next to the south Atlantic division, we see that the students from this section are attracted to the six eastern universities in the same order as last year, namely, *Cornell, Pennsylvania, Columbia, Harvard, Yale, Princeton.* *Michigan* is the only one of the three western universities here included that makes any showing in this division, being exceeded by all of the eastern universities, while of the colleges *Lehigh* is the only one that is at all well represented, the south Atlantic following of this institution being in excess even of that of *Princeton*. As far as the individual states are concerned, *Pennsylvania* leads in Delaware, *Cornell* in the District of Columbia and in Virginia, *Pennsylvania* and *Yale* in Florida, *Columbia* in Georgia, North Carolina and South Carolina, *Lehigh* in Maryland, and *Pennsylvania* in West Virginia.

In the south central division *Harvard* heads the list (92 as against 80 last year), with *Yale* (89–80), *Cornell* (80–76), *Columbia* (75–72), *Pennsylvania* (64–44), *Michigan* (63–64), *Princeton* (63–72), *Illinois* (47–47) and *Lehigh* following in the order given, the representation from this section of the other institutions in the list being insignificant. The largest representation in the individual states is found at the following universities: Alabama—*Cornell, Columbia, Pennsylvania;* Arkansas—*Harvard;* Indian Territory—*Illinois;* Kentucky—*Harvard, Yale, Pennsylvania;* Louisiana—*Harvard;* Mississippi—*Columbia* and *Cornell;* Oklahoma—*Michigan;* Tennessee—*Yale, Cornell, Columbia;* and Texas—*Yale, Cornell, Columbia* and *Pennsylvania.* Kentucky sends by far the largest delegation to the institutions included in the list.

In the north central division the three universities of that section, *Michigan, Illinois* and *Wisconsin,* naturally head the list, ranking in the order named. Of the three institutions *Michigan* draws the largest percentage of students from outside of its own state, 54 per cent. of its enrolment hailing from Michigan, the corresponding figures for *Illinois* and *Wisconsin* being 83 per cent. and 84 per cent., respectively. It is thus seen that the clientele of the *Universities of Illinois* and *Wisconsin* is much more local in character than that of any of the eastern colleges or universities included in the table, whereas *Michigan* attracts a larger percentage of students from outside its own state than do *Pennsylvania, Columbia* and *Cornell* or *Lafayette* and *Lehigh, Harvard's* percentage being just equal to that of the *University of Michigan.* Of the eastern universities *Yale* has the largest clientele in this section of the country, followed by *Harvard, Cornell, Columbia, Princeton* and *Pennsylvania,* in the order named, *Yale* and *Harvard* having exchanged rank since last year. Comparing the figures for the past academic year with those for 1904–05, we see that *Yale's* representation has increased from 506 to 536, the greatest gain (119–135) having been made in the state of Ohio; *Harvard* has dropped from 526 to 487, the largest loss (160–137) having been experienced in the same state; *Cornell's* representation in this division has remained stationary, 381–380, *Columbia's* has grown from 262 to 287, *Princeton* has 219 this year as against 209 in 1904–05, while *Penn-*

sylvania has the same number, 139. Of the New England colleges *Dartmouth* has the largest following in the north central division, with *Williams* a close second, the latter having twice as many students from this section as *Amherst*. The representation of *Lafayette* and *Lehigh* in this as well as in the western division is insignificant. *California* has thirty-seven representatives from this division, which is less than that of any of the other universities or the New England colleges. Leaving the *University of Illinois* out of consideration, *Michigan* has the largest following in Illinois, followed by *Wisconsin, Yale, Cornell* and *Harvard*, each of which has over one hundred students from this state. *Michigan* also leads in Indiana, followed by *Illinois, Columbia, Harvard* and *Cornell*. In Iowa the order is *Illinois, Michigan, Wisconsin, Harvard* and *Yale;* in Kansas, *Michigan, Illinois, Yale, Harvard, Columbia;* in Michigan (leaving the state university out of consideration) *Yale, Columbia, Illinois, Harvard, Cornell;* in Minnesota, *Yale, Harvard, Wisconsin, Columbia, Michigan;* in Missouri, *Michigan, Yale, Harvard, Illinois, Columbia;* in Nebraska, *Illinois* and *Michigan, Columbia* and *Harvard;* in North Dakota, *Michigan* and *Wisconsin;* in Ohio, *Michigan, Harvard, Yale, Cornell, Columbia;* in South Dakota, *Illinois* and *Wisconsin, Michigan;* in Wisconsin (leaving the state university out of consideration), *Illinois, Michigan, Harvard, Yale, Columbia*. The largest number of students attracted to *Amherst* from this section hail from Missouri, while the main strength of *Dartmouth* and *Williams* lies in Illinois. Excluding in each case the respective state university, the state of Illinois is represented by 1,091 students at the institutions mentioned in the list, Wisconsin by 240 and Michigan by 200, *i. e.*, 72 per cent. of the state of Illinois representatives at all of the institutions included in the table are enrolled at the state university, while the percentage for Michigan and Wisconsin is 92.

In the western division (leaving *California* out of consideration) *Michigan* leads, as it did last year, with *Harvard* and *Columbia*, each of which attracts over one hundred students from this section, following; then come *Yale, Cornell, Illinois, Pennsylvania, Princeton*. *Amherst* and *Williams* attract only a few students from this division, *Dartmouth* being well represented only in Colorado. *Michigan* has grown from 134 to 149, its chief gain having been registered in Colorado; *Harvard* has dropped from 126 to 124, its main loss being in California; *Columbia* has grown from 111 to 117, the largest gain being in Utah; and *Yale* has grown from 78 to 93, the best gain being in Colorado. *Columbia* leads in Arizona, although the number is so small as to render the comparison of little value; in California *Harvard* still leads—leaving the state university out of consideration—with *Columbia* second; in Colorado the order is *Michigan, Yale, Harvard;* in Idaho, *Illinois* and *Michigan;* in Montana, *Michigan, Columbia, Harvard;* in Nevada, *California, Columbia;* in New Mexico, *California* and *Michigan, Harvard;* in Oregon, *California, Yale, Cornell* and *Harvard;* in Utah, *Columbia, Michigan;* in Washington, *California, Michigan, Pennsylvania;* and in Wyoming, *Michigan* leads. Of the states in the western division Colorado and California send by far the largest delegations to the eastern institutions in the list. The fact that the *California* figures are those for 1904–05 somewhat mars the value of the comparisons in this division, although the figures for the academic year just closed would probably show little change. The attendance of students from the state of Cali-

fornia at the eastern institutions will undoubtedly suffer a considerable loss in the coming year.

Cornell again leads in the number of students from the insular possessions, with *California* second, and *Harvard* and *Illinois*

(B) FOREIGN COUNTRIES

1905-1906	Amherst	California	Columbia	Cornell	Dartmouth	Harvard	Illinois	Lafayette	Lehigh	Michigan	Pennsylvania	Princeton	Williams	Wisconsin	Yale
North America	**2**	**7**	**46**	**48**	**2**	**51**	**10**		**17**	**21**	**37**	**7**		**11**	**27**
Canada	2	6	31	26	1	40	3		1	13	8	4		1	25
Central America			1	4			1				13			1	
Cuba			7	12		2			9		7	2		1	
Mexico		1	6	6	1	6	6		5	7	3	1		5	1
West Indies			1			3			2	1	6			3	1
South America		**2**	**9**	**30**		**1**			**3**	**2**	**9**			**5**	**1**
Argentine Republic		1	2	7		1								4	
Brazil			1	11							6			1	1
Chili			3							1	3				
Colombia			2	1					1	1					
Ecuador				2					1						
Peru		1	1	9					1						
Europe	**1**	**5**	**50**	**22**	**1**	**32**	**6**		**1**	**12**	**49**	**7**		**4**	**21**
Austria-Hungary			2								2				
Belgium			1								1				
Bulgaria				1						1	1				
Denmark		1												1	1
France	1		8	1		6					15	1			3
Germany		1	12	2		6	1			3	5	5		2	
Great Britain and Ireland		3	11	4		9				2	10			1	4
Holland			1	2		1				2	1				
Iceland						1									
Italy			2			3	1				4				
Norway				3		1	2								1
Portugal							1								
Rumania											1				
Russia			6	2							7				
Spain			2				1								
Sweden			2	2					1		1				
Switzerland			1	1											
Turkey			2	4	1	5				4	1	1			12
Asia	**4**	**18**	**38**	**20**		**21**		**3**		**12**	**14**	**5**	**2**	**6**	**31**
Ceylon												1			
China		9	10	9		3		1		1	1				4
India	1	1	3	7		1		2		2	1		1		1
Japan	3	8	24	4		16				9	11	4	1	6	24
Persia			1												
Turkey (in Asia)						1					1				2
Africa		**1**	**4**	**2**		**2**	**1**		**1**			**1**	**1**		**2**
Cape Colony												1			
Egypt							1								
Morocco						1									
South Africa		1	4	2		1			1				1		2
Australasia		**6**	**8**	**8**		**5**	**1**				**21**				**8**
Australia		3	2	7		1					14				3
Friendly Islands		1													
New Zealand		2	1	1		4	1				7				
Total (Foreign Countries)	7	39	150	130	3	112	18	3	22	47	130	20	3	26	85
Total (United States)	453	3268	4083	3255	995	4319	3447	347	634	4133	2914	1364	445	3216	3063
Grand Total	**460**	**3307**	**4233**	**3385**	**998**	**4431**	**3465**	**350**	**656**	**4180**	**3044**	**1384**	**448**	**3242**	**3148***

*Omitting 64 non-resident graduate students.

third. *California* leads in the Hawaiian Islands, and *Cornell* in the Philippines and in Puerto Rico. There is quite an increase in the total number of students from the Philippine Islands and Puerto Rico over last year at the universities included in both this and last year's tables. Alaska is not represented this year at any of the institutions in the list.

As was pointed out in the introductory paragraph, the gain during the past year in the number of students from foreign countries has been quite marked, the increase for the six eastern universities included being one from 540 to 627, a growth of no less than 16 per cent., to which the various continents contributed as follows: North America's representation has grown from 212 to 216; South America's from 37 to 50; Europe's from 116 to 181; Asia's from 107 to 129; Africa's remained stationary at 11, and Australasia's has dropped from 57 to 40, this loss being attributable chiefly to the decrease of 15 in the figures for the *University of Pennsylvania,* which attracts the largest number of Australasians.[1] A glance at the accompanying table will show that *Columbia* has the largest foreign clientele, having exchanged places with the *University of Pennsylvania,* which this year is tied with *Cornell* for second place, *Harvard* occupying fourth, as it did last year. The attendance from foreign countries at *Columbia* has grown from 117 to 150 during the past year, that of *Cornell* from 100 to 130, that of *Pennsylvania* from 126 to 130, that of *Harvard* from 94 to 112, that of *Yale* from 83 to 85, that of *Michigan* from 38 to 47, and that of *Princeton* has remained stationary at 20. Of the western universities *Michigan* attracts the largest number of students resident in foreign countries, followed by *California, Wisconsin* and *Illinois* in the order named. It will also be noted that the attendance of foreigners is almost exclusively confined to the larger universities, although *Lehigh* during 1905–06 attracted 22, as against 7 for *Amherst,* and 3 each for *Dartmouth, Lafayette* and *Williams. Lehigh's* excellent showing in this direction is explained by its reputation as a technological school, this particular field being the one that draws the majority of foreign students, although the foreign clientele in the non-professional graduate faculties of the larger universities is rapidly on the increase. It is safe to predict that the growth in the number of foreigners attending our higher institutions of learning will be as uninterrupted in the immediate future as it has been during the past few years. Examining the representation of the different institutions by continents, we note that the order in North America is *Harvard, Cornell, Columbia, Pennsylvania, Yale, Michigan;* in South America, *Cornell, Columbia* and *Pennsylvania, Wisconsin—Cornell* being the only institution in the list that makes a respectable showing; in Europe, *Columbia, Pennsylvania, Harvard, Cornell, Yale, Michigan;* in Asia, *Columbia, Yale, Harvard, Cornell, California, Pennsylvania;* in Africa *Columbia* leads, while in Australasia the order is *Pennsylvania, Cornell, California, Harvard.* The two most interesting phenomena to be observed here are the rapidly increasing delegations from Europe on one hand, and on the other the comparatively meager showing made by South America. It certainly seems strange that the South American republics are not better represented by students at the universities of the United States. As for individual countries, *Harvard* leads in Canada, followed by *Columbia, Cornell* and *Yale; Pennsylvania* has the best Central American representation; *Cornell* attracts the largest num-

[1] A portion of the information contained in this paragraph was published in the *New York Evening Post* of July 21, 1906.

ber of Cubans, *Michigan* the largest number of Mexicans and *Pennsylvania* the largest number of West Indians. Of the North American countries, Canada sends the largest number of students—161—followed by Mexico with 48 and Cuba with 40. *Cornell* leads in the Argentine Republic, Brazil, Ecuador and Peru; *Columbia* in Colombia, and with *Pennsylvania* in Chili, although the representation in the last two countries is insignificant. Of the South American countries, Brazil sends the largest representation, namely, 20, followed by the Argentine Republic with 15 and Peru with 12. In the European countries that send ten or more students the order is as follows: France—*Pennsylvania, Columbia, Harvard;* Germany—*Columbia, Harvard;* Great Britain and Ireland—*Columbia, Pennsylvania, Harvard;* Italy—*Pennsylvania, Harvard;* Russia—*Pennsylvania, Columbia;* Turkey—*Yale, Harvard.* Great Britain and Ireland sends the largest number, namely, 44, followed by Germany with 37, France with 35 and Turkey with 30. Of the Asiatic countries, Japan sends 110, China 38 and India 20, the representation from the other countries being unimportant. *Columbia* draws the largest number of students from China, leads with *Yale* in Japan, and follows *Cornell* in India. Of the Australasian countries, Australia sends 30 and New Zealand 16, *Pennsylvania* leading in both, followed by *Cornell* in the former and by *Harvard* in the latter.

RUDOLF TOMBO, JR.

SCIENTIFIC BOOKS.

The Analysis of Racial Descent in Animals. By THOMAS H. MONTGOMERY, JR., Professor of Zoology in the University of Texas. Pp. xi + 311. Henry Holt & Co. $2.50.

A general and comprehensive work on the methods of determining racial descent has not appeared within recent years and Haeckel's 'Generelle Morphologie,' first published in 1866, still remains the standard work on this subject. The insufficiency of some of the methods outlined by Haeckel has been repeatedly pointed out, but there are few, if any, works which deal with these methods both critically and constructively. Recent analytical studies in biology have turned the interest and sympathies of many biologists away from the more general, if less exact, speculations of the older school, and have brought the study of phylogeny into a certain disrepute. Nevertheless, as the author says in his preface, "many of the broader concepts of biology have been obtained from just such investigations. As to the degree of uncertainty in its conclusions, this results simply from the great extent of the phenomena to be explained and from their complexity."

The first chapter of this work deals with 'Environmental Modes of Existence.' In addition to the general classification of organisms into the *geobios, limnobios* and *halobios* of Haeckel, the author recognizes two other groups—the *diplobios* (organisms which spend part of their life in one medium, part in another) and the *entobios* (entoparasites); the first three of these modes of existence he groups together under the name *monobios,* the last two under *heterobios.*

The question as to which of these modes of existence is the most primitive is interestingly discussed and the conclusion reached that the evidence favors the hypothesis of Simroth that 'the sea beach from the region of high tidal limit to a short distance below the low tidal, is the probable point of origin of most animal groups.'

Regarding the seasonal migrations of various animals the author concludes that there is no evidence that the earliest environment of the young represents the ancestral home of the species. As to the method of origin of entoparasites he concludes that where there are a number of different hosts in the life history of the parasite, *e. g.,* Trematodes, the host in which the adult condition is reached is the primitive one, whereas the occurrence of younger stages in an intermediate host is a later adaptation. "Here the ontogeny would be a reversal of the phylogeny with regard to the sequence of hosts."

In the second chapter on 'Heredity and Embryonic Differentiation' the author gives a brief account of the statistical, and a more extended account of the cytological studies of heredity. He calls attention to the importance of the nuclear linin in the preservation of the characteristic number and form of the chromosomes and he concludes that the linin should always be considered along with the chromatin and that both linin and chromatin constitute the germ-plasm. The hereditary significance of the conjugation of male and female chromosomes, and of their separation in the reduction division first discovered by the author, is discussed. In his treatment of embryonic differentiation the position is taken that the ability of egg fragments to give rise to whole embryos, no more indicates the undifferentiated character of the fragments than the similar ability on the part of adult planarians.

The third chapter on the 'Relations of Modes of Reproduction and Conjugation' is less convincing in its conclusions than the preceding ones. The evidence presented in favor of the view that fragmentation is more primitive than binary fission is not convincing; and the same is true of the conclusion that Geddes and Thompson's theory of sex must be abandoned because sexuality is 'the state of occurrence of dissimilar individuals,' only one of which, the egg, has the power to reproduce. Similarly the conclusion that the male is morphologically and physiologically inferior to the female, while supported by many examples, meets with so many exceptions as to cast doubt upon its general applicability or value. The statement that 'sexuality finds its expression and origin in extra-chromosomal differences' does not accord with the recent careful work of Stevens and Wilson. And the statement that every Metazoan formed from a fertilized egg cell is initially a hermaphrodite, because formed by the fusion of male and female germ cells, while an animal arising from an unfertilized egg is initially female, though it may later become male, seems to the reviewer to confuse sex with sex cells and thereby to create many needless difficulties. Finally the evidence brought forward at the close of the chapter in favor of the view that 'eventual hermaphroditism' is a secondary condition and not primitive is not wholly satisfactory, for it does not necessarily follow that 'because of its [separate sexes] more general occurrence it would seem to be more primitive.'

The fourth chapter contains an extensive treatment of 'Life Cycles and Polymorphism of Individuals.' The author concludes that 'all cases of metagenesis have originated from larval development, and that asexual reproduction is limited to an immature or larval stage.' Practically he makes no distinction between larval development with metamorphosis and metagenesis, or in his own words, 'All discontinuous larval development is metagenetic, in that the adult is formed asexually, by budding from the larva.' This discussion is of service in showing that there is no hard and fast line between metagenesis and discontinuous larval development, but there seems to be no good reason for changing the old definition of metagenesis, viz., 'an alternation of a sexually produced generation or person with an asexually produced one,' for this new definition, even though in some cases there may be no sharp line of demarcation between the alternation of 'persons' in metagenesis with the alternation of 'organs' in larval development.

Under 'ekdytic development' the author includes those cases, commonly known as fetal development, in which special annexes are formed, which are later lost. He considers that Beard is right in classifying fetal development as discontinuous, but wrong in regarding it as a form of larval development.

The fifth chapter deals with 'Variations and Mutations' and represents in a brief form the relations of the mutation theory of de Vries to the germ-plasm theory of Weismann. The tabular classification (p. 135) of the conditions of variation and mutation, and of the resulting types of variants and mutants is a brief and useful summary. As to the cause of atypical forms he says (p. 146): 'Our conclusion is that variation, progressive or regressive, and also mutation, in fact any inherited modification of the race, is instituted by stimulus of the environment'; and again

he says (p. 149): "It follows, accordingly, that in neither of the known kinds of bastardization, the Mendelian or the unisexual, is there any evidence that variations or mutations are produced by these processes. Parental qualities are transmitted according to more or less definite laws, but no new ones are produced." On the basis of such considerations he concludes that acquired characters are inherited. "Indeed the very postulation of the question, 'are acquired characters inherited?' is absurd. It should read rather, 'what kinds of acquired characters become inherited?'" Regarding the statement of de Vries that the answer to this question 'depends to a great extent upon a word play; just according as one chooses his definition for acquired characters, he regards them as heritable or not,' Montgomery says:

> Here, however, de Vries himself makes a word play; acquired characters, according to him, are those only which do not arise suddenly, *i. e.*, individual variations and not mutations. But according to all essential ideas of his mutation theory the mutations are much more distinctly, even solely, steps in the formation of races, and a step in racial progress is surely nothing less than an acquisition.

This is as striking an illustration as could be found of the need of clear definitions, and of the fact that long continued discussions in science more frequently arise from misunderstandings than from fundamental differences of opinion. For what Montgomery calls 'acquired characters' or 'steps in racial progress,' would be called by Weismann or de Vries 'germinal characters,' while the question of the transmissibility of 'acquired characters' in the sense of Weismann, *i. e.*, somatic characters which are, *ex hypothesi*, not represented in the germ, is not discussed by Montgomery. Weismann and many others use the term 'acquired character' in a peculiar and specific sense, Montgomery with a general and colloquial meaning.

The sixth chapter deals with the 'Transmutation of Species.' It begins with an appreciative account of the part of Lamarck in establishing the theory of evolution, and an interesting discussion of the question of the monophyletic or polyphyletic origin of organisms. The unfortunate prominence of hypothetical ancestors in many evolutionary discussions is excellently set forth in these words: "From the casual inspection of certain writings, and most unfortunately those intended for beginners, one might infer that the *Moneron*, the *Gastræa*, the *Trochozoon*, and the *Bathybius* were more important, if not more real, than the living animals around us."

He concludes that transmutations are definitely directed and that they may be discontinuous, by means of mutations, as de Vries has shown, or continuous, by means of variations. As an illustration of the latter he considers the different geographical races or subspecies of the song sparrow, *Melospiza cinerea*, the geographical as well as morphological intergradations of which indicate that these are not mutants but variants. He concludes, therefore, that 'the mutation theory has not disproved the possibility of perfectly gradual transmutation of species, but has only shown that sometimes transmutation may not be a gradual process.' The author takes an equally broad view with regard to the causes of mutation and variation, holding that 'the factors are neither purely extrinsic, nor purely intrinsic, but a combination of the two.'

The chapter on the 'Parallelism of the Ontogeny and the Phylogeny' contains an extremely interesting and valuable résumé of the 'recapitulation theory.' This is followed by a critical consideration of the whole question, and the conclusion is reached "that the embryology does not furnish any recapitulation of the phylogeny, not even a recapitulation marred at occasional points by secondary change. * * * An analysis of the stages during the life of one individual can in no way present a knowledge of its ancestry; and the method of comparing non-correspondent stages of two species is entirely wrong in principle."

In the chapter on 'Morphological Comparisons' the author argues that in comparison of organisms the whole life cycle should be considered as well as all structural characters, and he strongly insists that only corresponding stages in the ontogeny can properly

be compared, the two stages, which can be most readily determined to be correspondent, being the first and the last. This, together with the greater amount of differentiation found in the adult stage, leads him to the conclusion that end stages in the ontogeny are more important for purposes of comparison, than any other stages. The rigid application of this principle leads him to some very unusual conclusions; *e. g.*, most zoologists will be astonished at the statement that *Sacculina* is not a Crustacean, because in its adult condition it has lost the Crustacean characters which it possessed as a larva. Similarly the statement that the group Chordata is inadmissible because tunicates, Amphioxus and vertebrates are very unlike in the adult condition, though their larvæ show fundamental resemblances, seems to the writer to be out of harmony with the broad and liberal method of comparison advocated in the closing section of the chapter, viz., 'to neglect nothing, to consider every property, kind of individual, every embryonic stage,' etc.

The chapter on the 'Relative Values of Morphological Characters' deals with many interesting questions. The author concludes that types of symmetry—radial, spiral, bilateral—are of little phylogenetic significance, but that metameric segmentation is of great importance. An excellent review of the theories as to the origin of metamerism is followed by the author's view that metamerism has arisen, not from asexual reproduction, but from division of organs, 'Just as one cell gives rise to others by division, so one organ produces others by division.'

In general the conclusion is drawn that the most important of all morphological characters for the purpose of comparison are those which relate to the relative position and connection of parts.

In the tenth chapter the 'Criteria of Racial Advancement' are discussed. Whether an organism is to be regarded as 'high' or 'low,' is, according to the author, dependent entirely upon the length of its line of descent, irrespective of its final complexity or simplicity. This again leads to some very unusual conclusions and causes one to doubt the value of any such definition.

Limits of space have made it necessary to consider only a few of the subjects treated in this work, and the author's conclusions have been stated without presenting the cogent, if not always convincing, arguments by which these conclusions are reached, nevertheless this review will serve to show the great extent and importance of the subjects treated. The author's intimate acquaintance with the great wealth of phenomena and with the extensive literature dealt with in this book, makes it one of particular importance and value to biological students.

E. G. Conklin.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Comparative Neurology and Psychology for July contains the following articles: Dr. G. E. Coghill describes the 'Cranial Nerves of *Triton tæniatus*,' comparing the microscopic anatomy and nerve components with *Amblystoma* and the forms described by Drüner. 'Retrograde Degeneraton in the Spinal Nerves,' by S. Walter Ranson. An experimental study of the atrophic changes in both spinal nerves and the cells of the spinal ganglia and spinal cord with special reference to the differences between the typical Wallerian and the retrograde degeneration. 'The Primitive Pores of *Polydon spathula*,' by Herbert D. Kistler, describes with a plate the peculiar sense organs on the bill of the spoon-bill catfish. 'The Reactions of Crayfish to Chemical Stimuli,' by James Carleton Bell. A careful examination of the whole body surface to discover its sensitiveness to various types of chemical solutions. An editorial on abnormal psychology and book notices complete the number.

The *Botanical Gazette* for July contains the following papers: E. C. Jeffrey and M. A. Chrysler discuss the Cretaceous *Pityoxyla*, describing two new species, one from the Middle Cretaceous of Staten Island, the other from Massachusetts. Certain differences from modern pines are pointed out and regarded as ancestral. H. L. Shantz publishes a result of his study of the vegetation of the Mesa region

east of Pikes Peak, discussing the Bouteloua formation as to its structure. Aven Nelson publishes 15 new species of seed plants from the Rocky Mountain region. George J. Peirce gives an account of *Anthoceros* and its Nostoc colonies, showing the fallacy of Prantl's argument that because cavities and hairs do not develop in the usual way except where the colonies are, the liverwort must profit by such an association.

DISCUSSION AND CORRESPONDENCE.

GLACIATION IN THE SONORAN PROVINCE.

TO THE EDITOR OF SCIENCE: In the current number of SCIENCE[1] Dr. Frederick J. H. Merrill directs attention to moraine-like accumulations of debris observed by him at a number of localities in northern Sonora and southern Arizona and New Mexico; of which accumulations part are well known to me—though my provisional interpretations differed from those of Dr. Merrill. The district is too extensive and too little known to warrant broad generalizations or to justify negation of the suggestions offered by so acute an observer as Dr. Merrill; yet future observers may be aided by the alternative suggestions growing out of my own observations in half a dozen journeys in the saddle (with others by rail and stage) through the Sonoran province.

So far as my observations go, the more extensive debris accumulations of the type described by Dr. Merrill (including those in the borrow-pit near Nogales and thence southward to Imuris) are confined to districts of late Mesozoic or Cenozoic vulcanism; while in some cases the accumulations appear to pass both horizontally and vertically upward into undoubted volcanics, much as the tuff beds underlying each table mountain in California grade into more firmly lithified lava sheets. Concordantly, my interpretation of the debris accumulations was that they were originally, and sometimes are now, volcanic tuffs and breccias much like those found further northward along the Pacific coast save that the brecciated structure is more striking than I have seen elsewhere. Frequently the breccias and lava sheets overlie massive blue limestones undoubtedly equivalent to the vast Mesozoic (Cretaceous and Jurassic) limestone series of northeastern Mexico, and probably equivalent to the shale-mixed limestones of the Sierras, especially in southern California; and within a few miles of the borrow-pit south of Nogales (by which I once had occasion to camp for three days while awaiting official documents from Mexico) there are considerable exposures of this limestone, weathered as usual into the peculiar rugose surface—miniature mountain ranges and valleys—found by Hill and others to be characteristic of the Mesozoic limestones in the eastern Sierra Madre. The calcareous deposits are seen in places to rest (and probably everywhere lie) unconformably on granites, which in western Sonora and southwestern Arizona are of wide extent; yet neither on the limestone nor on the granitic terranes have I observed such debris accumulations as those so characteristic of the Imuris or Opodepe valley. Certain of the accumulations in this valley seemed to me well worthy of critical study as breccias primarily volcanic though accumulated in part by concurrent aqueous agencies, and recording in themselves a peculiarly complex volcanic history; for in several sections there are imbedded in the clay-like matrix angular boulders yards in dimensions, sometimes containing included boulder-like masses feet across, themselves made up of brecciated constituents inches or less in diameter. A part of the heterogeneous accumulations both in Imuris Valley and elsewhere were interpreted by me as rearranged breccias transported to limited distances and redeposited by sheetfloods or other freshets during the rather remote periods in which the lava sheets and tuff beds were newly exposed to surface erosion. In this connection it is to be noted that the province in question is the type region for sheetflooding, and that both the lower slopes of the sierras and the intervening plains are shaped by this agency; and also that sheetflood deposits are normally heterogeneous and ill-assorted accumulations of coarse and fine material, seldom perceptibly stratified or graded from coarse to fine either horizontally or vertically in the single section.

[1] Volume XXIV., pp. 116–118.

My interpretations were influenced by what seemed to me negative evidence both in topographic forms and in surficial materials throughout the lower ranges and intervening plains of western Sonora and southern Arizona. I have ridden over and camped on the country between Arivaca and Sopori (mentioned by Dr. Merrill), where the erosion forms assumed by the widespread tuff beds often simulate morainal deposits in general landscape effects, without finding indications of glacial agency either in deposits or in minute topography; while over the more elevated remnants of eroded ranges and among the lower slopes of the more rugged sierras most of the topographic forms impressed me as not merely water-cut but carved in that peculiarly acute fashion characteristic of the margins of sheetflood plains. Some of these plains are indeed diversified, especially toward the mountain margins, with both basin-shape depressions and debris-heaps, the latter frequently near the valleyward extremities of the former—the basins having been originally places of concentrated flow of the (generally dwindling) sheetfloods, and the debris-heaps the delta-like accumulations by which the localized corrosion was originally checked; though the heaps usually outlast the basins, especially when composed largely of obdurate rock-fragments, and form a type or genetic class of those natural mounds which are of late attracting much attention. The region is one of distinctively significant geomorphy; for it is not only the type district of sheetflood erosion, but comprises an extensive area of retrogressive carving due to a southwestward tilting—an area in which the general divides seldom coincide with the axes of the sierras but run far out on the low-lying plains between, circumscribing the head slopes of waterways (of which Rio Seco and Rio Bacuache are types) that have retrogressed northeastward entirely through the ranges in which they originally headed. Several examples of this remarkable retrogression were surveyed and mapped in detail by Willard D. Johnson in connection with that expedition which yielded his notable map of Seriland published in the *National Geographic Magazine* and also in the Seventeenth Annual Report of the Bureau of American Ethnology; unfortunately, these surveys have not yet been published. During this same expedition Mr. Johnson worked over most of the surface and ascended most of the crests along the valleys lying next west of that of the Imuris; but neither he nor I noted ice-shaped topography anywhere in the region. Of course, any negative inference is worth far less than the positive inductions of a geologist familiar, like Doctor Merrill, with such glacial topography and deposits as those of northeastern United States; yet it is worthy of consideration pending more extended surveys than have thus far been found practicable in the Sonoran province.

W J McGee.

Saint Louis Public Museum.

THE EARTHQUAKE AND PROFESSOR LARKIN.

In the *Open Court* for July, 1906, is a remarkable account of 'The Great San Francisco Earthquake,' from the pen of Edgar L. Larkin, of the 'Lowe Observatory on Echo Mountain,' otherwise professor of astronomy and geology in the University of the Sunday Supplement.

Professor Larkin came to San Francisco immediately after the earthquake of April 18. In a day or two he was able to discover a number of things which had escaped the notice of the local geologists, Lawson, Branner, Gilbert, Campbell, Davidson and others, constituting the official State Earthquake Commission.

Professor Larkin says: "One of my objects in leaving the peace and quiet in the observatory on the mountain, to make a five-hundred-mile journey to the stricken city, was to study the action of the earthquake in the great cemeteries. The fallen columns write the history of the convulsion in stone." To his surprise he found that "the half dead made their homes with the dead. Weak and wan girls played with the marble angels. * * * One desolate family found shelter in a beautiful sepulchre while the sufferers rested their heads on lowly graves." This was the more remarkable, for, as Jerome Hart suggests in the same connection, there is in California a

deep-rooted superstition that it is unlucky to be killed by a falling tomb during an earthquake. Yet in this stress, superstitions fell away like dead leaves and the people slept through the long night with fallen angels among beds of violets.

And this stress was, indeed, terrible. "The Pacific," observes Professor Larkin, "was startled with the onrush of the terror-stricken. * * * The glorious poppies of California vied with each other in striving to attract attention away from the appalling scene * * * but in vain."

"One of the most vivid, awe-inspiring and impressive facts * * * is this: the people in the city did not hear subterranean sounds! But the awful reason why was because of the terrible roar roundabout, from seething flames, tumbling walls, the crashing of glass and the hissing of sliding, rasping miles of wire. The literature of earthquakes does not present a more striking and startling fact, for the roaring of the city all aflame was louder than the thundering in caves of gloom below." Other observers failed to note that the city was already roaring with 'seething flames' in the forty-seven seconds through which the shock lasted.

It is interesting to see how accurately the lower animals predicted the earthquake. In San José, eighteen minutes before the shock, "two mares with young colts were running and whinnying * * * in alarm as though dogs were after them. Dogs were there, but they, too, gave unusual warning of danger. * * * I have," observes Professor Larkin, "a mass of facts that can not be mentioned in less space than a good-sized book." It was in San José, also, three days before the earthquake, so I am informed, that a cat was heard to utter three sounds sharp and high, these followed by a hiss as of escaping steam. A dog was present and appeared also agitated. It was noticed that the dog's nose was cold, while the tail of the cat was rigidly erected. At Petaluma, it is said, a cock (white Leghorn) crowed three times, on the morning before the shock.

"Many fish," continues Professor Larkin, "were killed along the coast and as far south as Los Angeles. And fish taken from the sea opposite Los Angeles had such a strong odor of sulphur that they could not be eaten." This is the more remarkable as Los Angeles is five hundred miles from the point where the earthquake rift leaves the sea. But it may be noted also that the shock went twice around the world, and that there were fishes in the market of Tokyo on April 18 that had also such a strong odor that they could not be eaten. It is not stated whether the odor was that of sulphur, a matter to be investigated. In or near London, two months later, an odor of sulphur, or sulphuretted hydrogen, was detected in certain suddenly opened eggs which had been laid on or near the eighteenth of April. This is given on the authority of a distinguished actor lately returned from a tour in the provinces.

Another 'remarkable' fact is this: "The immense bay of San Francisco is filled and emptied by tides. The volume of water is enormous, and if forced through the Golden Gate, the current would be rapid, indeed. No such velocity exists, hence there may be an underground connection with the ocean." It is a singular fact that none of the local geologists have ever seen San Francisco Bay emptied. Still it might happen under cover of dense fog. In any case no great stress should be laid on this failure to observe, which has at most merely negative value.

Professor Larkin notices that although no sun spots greater than twice the size of the earth were visible at that time, yet on April 18 the sun, moon, Mercury, Venus, Mars, Jupiter and Saturn were massed within five hours twenty-eight minutes of right ascension. But, again, as the earthquake occurred at five o'clock thirteen minutes, this can not be held to prove anything; the seventeen minutes of discrepancy can not be overlooked. Moreover, Professor Larkin tells us the earth was at the time only 618,000 miles out of her usual orbit. This is not much for a globe which travels three hundred millions of miles a year and so is accustomed to deal with large figures.

The display of blue flames before the onslaught of the red ones, and their final yellow sequences was very remarkable. "The appear-

ance of blue lights," says Professor Larkin, "was over a wider area than at first thought. At Petaluma * * * blue flames eighteen inches in height played over a wide expanse of marsh land." Before the earthquake only "a flickering ominous haze was seen playing above the ground." "A dark funnel-shaped mass was seen in Fourth Street, San Francisco, suspended in the air, and it was illuminated by scintillating lights, like fire-flies." "Blue flames were seen hovering over the bases of foothills in western San Francisco." In San José, on the street called the Alameda, looking eastward, at the time of the shock the whole street was seen "ablaze with fire, it being of a beautiful rainbow color but faint. This, no doubt," observes Professor Larkin, "was an electrical display, for had gas been on fire all along the street the houses would have been ignited. And letters from a point north of San Francisco describe blue lights as flickering like an aurora over a wide area of marsh land with a troubled surface of adjoining water. And can it be that the giant Electricity took part in the vast seismic turbulence? * * * The writer scarcely knows which one of the multitude of theories regarding the cause of earthquakes to adopt."

Later Professor Larkin grows more confident and asserts that "the San Francisco earthquake was due to a readjustment of the edge of the layers once torn apart when the earth was young. * * * It appears that two faults were involved. * * * I do not wish to assert that the earth's charge of electricity helped in the havoc, but believe that it did. That giant is able to do any vast work."

No wonder that in Professor Larkin's mind 'great questions arise.' "Did man appear on earth before his dwelling was ready? Does nature care whether man exists? It is asserted that she has slain thirteen million human beings by convulsive force alone within the historic period."

'Swing low, Sweet Chariot,' sings Professor Larkin, with cheerful relevance. And, indeed, when we stop to think of it, why not?

D. S. J.

SPECIAL ARTICLES.

TIME VARIATION OF THE INITIAL NUCLEATION OF WET DUST-FREE AIR.

In the further development of the investigation[1] on the time variations of the efficient colloidal nucleation in filtered air, I find results of the same character as those already discussed; but the dependence of the nucleation on the fluctuations of the barometer shows itself even more obtrusively than before. The minima of atmospheric pressure coincide with maxima of the larger colloidal nucleation and therefore (by inference but not necessarily) with minima of ionization of the dust-free air, both in the daily and in the weekly periods of observations. Maximum pressure would correspond to maximum ionization as if the radiant energy originated in the compression of the atmosphere, or were dependent on the mass of the atmosphere bearing on a given place. This would, if finally substantiated, be an important result, but no more so than the correlative result that minimum pressure and maximum of the initial colloidal nucleation of dust-free air go together. The bearing of this on 'adsorption' of atmospheric ionization will be stated presently.

At the same time since the change of absolute temperature, t, due to sudden expansion equivalent to a drop δp at a barometric pressure p and vapor pressure π may be written

$$t_2/t_1 = (1 - \delta p/(p - \pi))^{(k-c)/c}$$

the correction for the changes of the barometer are in the same sense as the observed changes in nucleation. These corrections are found by varying the numerator of $\delta p/(p - \pi)$ and observing the effect on the angular diameter of the corona. While I see no room for error, it must nevertheless be acknowledged that the present method of small exhaustion (though possibly more sensitive) is not as straightforward as the method mentioned in my address where no variation could be detected, the terminal corona remaining unchanged.

At the present stage of investigation, therefore, the need of any cosmical radiation has ceased to be obvious and should be abandoned,

[1] Science, XXIII., p. 952, 1906.

and the results, if they are not due to some obscure barometric effect which has escaped me, are most directly referable to changes of pressure within the atmosphere, the number of the colloidal nuclei specified being greatest when the pressure is least. This view, moreover, would not be incompatible with the persistence of terminal coronas referred to above. It is also compatible with the following. If among the initial nuclei entrapped (which lie very near the region of ions) the ions actually preponderate, the observations would then mean that increased ionization accompanies the falling barometer. Under these conditions, however, radioactive emanation is known to be withdrawn from the stagnant air within the porous ground and the earth generally. Hence the data could now be interpreted as evidence of the necessary fluctuation of such emanation with the barometer.

I may add that I have since installed a second apparatus side by side with the first and that the data, though differing in their details, show the same dependence on the barometer in their broader time variations.

CARL BARUS.

BROWN UNIVERSITY.

USE OF THE TERM PERMIAN IN AMERICAN GEOLOGY.

FOR over fifty years the Permian question has been one of the moot problems of American geology. Of late it has been quite generally agreed that the title should not, at least, be applied to any American formation having the taxonomic rank of period or system, coordinate with such terms as Carboniferous or Cretaceous.

Division is now upon the point whether the so-called Permian section as represented in Kansas should be called by Murchison's title and given the rank of series, or whether the name should not be abandoned altogether as a designation for any American formation.

Upon this point Professor Prosser has recently made a summary of opinion. Among the statements is this: "There is still a difference of opinion among American geologists in regard to the correlation of the Upper Paleozoic formations of Kansas with the Russian Permian. The *Journal of Geology*, published in 1898 'A Symposium on the Classification and Nomenclature of Geologic Time-divisions,' in which Dr. Williston, Professor Calvin and Dr. Keyes reported adversely both as to the identification of the Permian in Kansas and as to its recognition as a period coordinate with the Carboniferous or Devonian; while Dr. William B. Clark stated that for the later divisions of the Paleozoic he should employ the chronologic terms Carboniferous and Permian."

Professor Prosser further observes: "No one has, perhaps, insisted as strenuously as Dr. Keyes that the name Permian should be dropped from American geology. In 1897 he attended the sessions of the International Congress of Geologists at St. Petersburg and participated in the excursions to the Carboniferous and typical Permian of Russia. Later he prepared a paper on the 'American Homotaxial Equivalents of the Original Permian,' and quotations from this can not be regarded as from one favoring the retention of the name 'Permian.'"

It is quite manifest that Professor Prosser has objected to my usage of the title of 'Oklahoman series' for the so-called Lower Permian of Kansas. My repeated use of the term Oklahoman has been made advisedly. It had been thought quite desirable to have the title of this section distinctive, irrespective of what age might be eventually assigned to it.

The recent discovery in New Mexico and Texas of a great formation (Guadalupan series) having a thickness of more than 2,500 feet, that appears to be intercalated between the Carboniferous Red Beds (Cimarronian series) and the equivalent of the Oklahoman series, indicates that the Kansas section of the latest part of the Paleozoic is not nearly so complete as it was thought to be. It also suggests that in Kansas there are no formations below the Red Beds that can be considered of late Carboniferous age, or that might be paralleled with the Permian at all. This, it would seem, would almost put an end to the contention for a Permian age of such Kansas beds as the Neosho, Chase and Marion formations.

Tschernychew, who is one of the best au-

COMPARATIVE TABLE OF CARBONIFEROUS FORMATIONS.

	Age.	Mississippi Province.	Southwestern Province.	Ural Province.
Carboniferous	Late	Cimarronian Wanting?	Cimarronian Guadalupan	Tataran (Upper P.) L. and M. Permian
	Mid	Oklahoman Missourian Des Moines Arkansan	Maderan Manzanan Wanting Ladronesian	Artinsk Upper Carboniferous } Middle Carboniferous
	Early	Mississippian	Socorran	Lower Carboniferous

thorities on the Russian Permian formation, and who has visited the Kansas localities, places the Marion beds, which are immediately beneath the Red Beds, on a level with the Russian Artinsk terrane. Personal observations in both fields point strongly to the correctness of this correlation. The Artinsk formation is older than any terrane of the original Permian sequence. Girty, who quite recently has also rather critically examined the Guadalupan section in Trans-Pecos Texas, concludes that if this fauna is Permian then certainly that of Kansas is not.

It would seem then that our conceptions of the American Permian formations must undergo very radical changes. Our scheme of comparison with the original Permian section of Russia would then be about as in the table given above.

Charles R. Keyes.
New Mexico State School of Mines.

QUOTATIONS.

PROFESSOR M'KENDRICK AND THE PROGRESS OF PHYSIOLOGY.

The valedictory address delivered by Professor J. G. M'Kendrick, at the close of the summer session of the University of Glasgow, on the occasion of his resignation of the professorship of physiology, provides a striking account of the progress of physiological science during the past thirty years. In 1861, when Professor M'Kendrick attended a course of lectures at Aberdeen, there was no attempt at demonstration except by diagrams and a few microscopes on a side-table. There were no experiments, and the only instrument displayed was a sphygmograph. But a little later Goodsir, of Edinburgh, brought from continental schools of physiology to the University of Edinburgh such instruments as myographs, kymographs, electrical appliances and other apparatus, and the teaching of practical physiology was soon firmly established under Argyll Robertson. Professor M'Kendrick himself installed similar teaching in the University of Glasgow in 1876, the date of his appointment to the chair of physiology. The requirements of modern physiological teaching are shown by a statement in the address that while Professor M'Kendrick has worked and taught for thirty years in five rooms, twenty-five are apportioned to physiological work in the new buildings. Reviewing the progress of physiology, Professor M'Kendrick detailed the advances made in histology and expressed the doubt whether much more progress can be expected. Graphic methods have been elaborated during the same period, and the action of electrical stimuli on muscle and nerve elaborately worked out. The study of the functions of living isolated organs, modern vivisectional methods, our knowledge of the nerve paths in the central nervous system, and the subject of internal secretions, are all among the triumphs of physiological science during the past thirty years, and were each passed in review. In conclusion, Professor M'Kendrick indicated physiological chemistry as the direction in which progress will be made during the next few decades.—*Nature.*

ASTRONOMICAL NOTES.

THE SYSTEM OF CASTOR.

Castor was one of the first close double stars known and one of those which led Sir William Herschel to the belief that such stars form real binary systems.

Belopolsky discovered, in 1896, that the fainter, preceding component of Castor, a_1 Geminorum, was a spectroscopic binary, having a period of about 2.9 days. In the June number of the *Astrophysical Journal* Dr. Heber D. Curtis gives an elaborate investigation of this system, which has been made at the Lick Observatory. The refined results now obtained amply confirm the general conclusions of Belopolsky. The final period found at the Lick Observatory is 2.928285 days.

Curtis has also discovered that the brighter, following component, a_2, is a spectroscopic binary having a period of 9.218816 days. Ignoring the faint and distant companion which also exists, Castor thus becomes one of the most wonderful stellar systems known. While the elements of the spectroscopic systems thus revealed are well known, less can be said of the visual components of Castor themselves. These have been observed since the time of the elder Herschel, but their motion is slow, and Burnham considers that the problem of finding the elements is indeterminate at present, and likely to remain so for a century. Different determinations of the period have varied from little more than 200 years to more than 1,000 years.

An interesting phase of this quadruple system lies in the fact that while the orbits of the components of a_1 are nearly circular, those of a_2 are very elliptical. The change in the mutual attractions of the components of so eccentric a system as that of a_2 must be great, and in other cases this has been found to be associated with variability in the light. On this account Mr. Curtis made some photometric determinations of the light of a_2, but no proof of variability was found. This need not cause surprise, however, since the physical condition of a star must determine whether such increased attractions would show themselves in a change of luminosity.

REFLECTING TELESCOPES OF SHORT FOCUS.

H. C. VOGEL, director of the Astrophysical Observatory at Potsdam, calls attention, in a communication to the *Kgl. Akademie der Wissenschaften*, Berlin, to the possibilities of short-focus reflecting telescopes. A translation of this article appears in the June number of the *Astrophysical Journal*. The competition, which has always existed between reflecting and refracting telescopes, is still keen, but at the present moment the reflector seems to occupy the center of the stage. Each form of instrument has certain limitations which are inherent, and each has distinct advantages over the other for certain purposes. A good reflector brings all the colors perfectly to the same focus, while the best refractor is not really achromatic. Also, the loss of light by reflection is in general much less than that by absorption. The result is that for nearly all objects the action of a reflector is much more rapid than that of a refractor of equal size. The circles of chromatic aberration may also cause a distortion of the form of the image of certain objects, such as the Orion nebula, when photographed with a refractor. On the other hand, the field of good definition is very small, in the case of the reflector. The images are perfect only at the center, and sufficiently good for use only over a region half a degree in diameter, or even less. Certain forms of the refractor, however, give good definition over a field ten, or even twenty, degrees in diameter. It is evident, therefore, that where a large field is required, as in making a photographic map of the sky, the refractor must be used. Over a small field, however, the reflector can photograph objects of such extreme faintness that they lie quite beyond the reach of the largest refractor.

Schwarzschild has shown that an extension of the field of the reflecting telescope may be obtained by the use of a second mirror. It is possible that the diameter of the field may be extended to several degrees in this way. Practically, this has not yet been done, but its successful accomplishment would mark an epoch in the history of the telescope. The power of the reflector evidently increases with the decrease of its focal length. Schaeberle has recently made some experiments to show how far this can be carried. He constructed a thirteen-inch reflector of twenty-inch focus, with which he was able to photograph stars of the seventeenth magnitude with an exposure

of only two minutes. The scale of the photographs, however, is so small that great magnification is necessary, and many details must be obscured, although the definition at the center of the small plates used appears to be good. There must be some practical limit to the decrease in the ratio of focus to aperture, and Schaeberle has apparently been working near, if not beyond it. Vogel gives some wonderfully good results obtained with a Schmidt mirror, using an aperture of 24 cm. which makes the ratio of aperture to focus 1:3.86. With the full aperture of 41 cm. and an exposure of ten minutes, many more stars were photographed than are visible in the great Lick refractor of more than 91 cm. aperture.

SOME CONSIDERATIONS REGARDING THE NUMBER OF THE STARS.

THE above title is the subject of a paper in the May number of the *Monthly Notices* of the Royal Astronomical Society. It is written by Miss Winnifred Gibson, B.Sc., and communicated by Professor Karl Pearson, F.R.S.

The problem is one of the deepest interest, but its solution is rendered difficult, if not impossible at the present time, by lack of fundamental data. The distribution of the stars would be readily determinable, if the parallaxes of a sufficient number had been determined. After confessing the lack of such materials, Miss Gibson, nevertheless, proceeds to an elaborate discussion of such data as exist. She arrives at the conclusion, for the brighter stars, that 'There is no sensible relation between magnitude and parallax.' The chief trouble with this conclusion is that it is derived from entirely inadequate data. The stars, whose parallaxes are taken into consideration, are of the ninth magnitude, and brighter. Of such stars there are in the sky about 150,000. For obtaining any law of relation between the magnitudes and distances of all these stars, the parallaxes of 72 stars, about one in 2,000, are available. Neither is there evidence that this small number is distributed by chance among the stars, nor that the parallax in many cases is sufficiently exact for purposes of discussion. Results based upon such meager data must have little or no value, however skillful and elaborate the treatment may be. Not much more can be said of that part of the discussion relating to proper motions and colors.

The latter part of the paper is concerned with the relation of magnitudes and frequencies, and gives results which are in substantial agreement with those of Professor E. C. Pickering, recently published, although Miss Gibson prefers a somewhat different formula. The author confines her attention to the brighter stars. The problem becomes at once more interesting and more difficult as it is extended to the fainter stars. Miss Gibson complicates the problem by assuming that magnitude is largely a physiological phenomenon, and hence that 'It is hardly conceivable that a scale of pure magnitudes could have any meaning in physical nature.' This is quite erroneous, since the determination of magnitudes, whether by visual or photographic methods, is simply the determination of the intensity of certain radiations, which surely have an objective reality based on physical conditions.

SOLON I. BAILEY.
HARVARD COLLEGE OBSERVATORY.

RECENT VERTEBRATE PALEONTOLOGY.

FROM the Brazilian Coal Commission, through Dr. I. C. White, state geologist of West Virginia, the American Museum of Natural History has just received the gift of a number of natural casts of a small Permian reptile closely related to the *Mesosaurus* of South Africa. These Brazilian remains have been carefully studied by J. H. McGregor for a memoir which will be published by the commission, and which for the first time gives us a complete knowledge of the anatomy of this extremely ancient reptile. It is related to the genus *Stereosternum* Cope, also from Brazil, which Baur made the type of the order Proganosauria, under the impression that these were very ancient and generalized reptiles. It is true they are very ancient but are not generalized, they are rather already considerably specialized for aquatic life, as shown in Dr. McGregor's restoration of the skeleton and

of the probable external form of this animal.

In this connection Dr. R. Broom, of Victoria College, Stellenbosch, South Africa, writes, under date of July 3: "An interesting point to remember is the horizon of *Mesosaurus* in South Africa. It is in the very lowest of the Permian beds—beds which the geologists are inclined to regard as Carboniferous, though I hold it is Permian. It is 5,000–6,000 feet below the Upper Permian beds, and perhaps the oldest true reptile known. *Mesosaurus* has nothing to do with the Plesiosauria."

H. F. O.

AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK, July 30, 1906.

THE PURE FOOD BILL.[1]

An Act preventing the manufacture, sale or transportation of adulterated or misbranded or poisonous or deleterious foods, drugs, medicines and liquors, and for regulating the foods, drugs, medicines and liquors, and for regulating traffic therein, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled:

[Public—No. 384.]

SEC. 1. That it shall be unlawful for any person to manufacture within any territory or the District of Columbia any article of food or drug which is adulterated or misbranded, within the meaning of this act; and any person who shall violate any of the provisions of this section shall be guilty of a misdemeanor, and for each offense shall, upon conviction thereof, be fined not to exceed $500 or shall be sentenced to one year's imprisonment, or both such fine and imprisonment, in the discretion of the court, and for each subsequent offense and conviction thereof shall be fined not less than $1,000 or sentenced to one year's imprisonment, or both such fine and imprisonment, in the discretion of the court.

SEC. 2. That the introduction into any state or territory or the District of Columbia from any other state or territory or the District of Columbia, or from any foreign country, or shipment to any foreign country of any article of food or drug which is adulterated or misbranded, within the meaning of this act, is hereby prohibited; and any person who shall ship or deliver for shipment from any state or territory or the District of Columbia to any other state or territory or the District of Columbia, or to a foreign country, or who shall receive in any state or territory or the District of Columbia from any other state or territory or the District of Columbia, or foreign country, and having so received, shall deliver, in original unbroken packages, for pay or otherwise, or offer to deliver to any other person, any such article so adulterated or misbranded within the meaning of this act, or any person who shall sell or offer for sale in the District of Columbia or the territories of the United States any such adulterated or misbranded foods or drugs, or export or offer to export the same to any foreign country, shall be guilty of a misdemeanor, and for such offense be fined not exceeding two hundred dollars for the first offense; and upon conviction for each subsequent offense not exceeding three hundred dollars or be imprisoned not exceeding one year, or both, in the discretion of the court: *Provided,* That no article shall be deemed misbranded or adulterated within the provisions of this act when intended for export to any foreign country and prepared or packed according to the specifications or direction of the foreign purchaser when no substance is used in the preparation or packing thereof in conflict with the laws of the foreign country, but this proviso shall not exempt said article from the operation of any of the other provisions of this act.

SEC. 3. That the Secretary of the Treasury, the Secretary of Agriculture, and the Secretary of Commerce and Labor shall make uniform rules and regulations for carrying out the provisions of this act, including the collection and examination of specimens of foods and drugs manufactured or offered for sale in the District of Columbia, or in any territory of the United States, or which shall be offered for sale in unbroken packages in any state other than that in which they shall have been respectively manufactured or produced, or which shall be received from any foreign

[1] Text of the bill adopted at the last session of the congress, approved by the president on June 30.

country, or intended for shipment to any foreign country, or which may be submitted for examination by the chief health, food, or drug officer of any state, territory, or the District of Columbia, or at any domestic or foreign port through which such product is offered for interstate commerce or for export or import between the United States and any foreign port or country.

Sec. 4. That the examinations of specimens of foods and drugs shall be made in the Bureau of Chemistry of the Department of Agriculture, or under the direction and supervision of such bureau, for the purpose of determining from such examinations whether such articles are adulterated or misbranded within the meaning of this act; and if it shall appear from any such examination that any of such specimens is adulterated or misbranded within the meaning of this act, the Secretary of Agriculture shall cause notice thereof to be given to the party from whom such sample was obtained. Any party so notified shall be given an opportunity to be heard, under such rules and regulations as may be prescribed as aforesaid, and if it appears that any of the provisions of this act have been violated by such party, then the Secretary of Agriculture shall at once certify the facts to the proper United States district attorney, with a copy of the results of the analysis or the examination of such article duly authenticated by the analyst or officer making such examination, under the oath of such officer. After judgment of the court, notice shall be given by publication in such manner as may be prescribed by the rules and regulations aforesaid.

Sec. 5. That it shall be the duty of each district attorney to whom the Secretary of Agriculture shall report any violation of this act, or to whom any health or food or drug officer or agent of any state, territory, or the District of Columbia shall present satisfactory evidence of any such violation, to cause appropriate proceedings to be commenced and prosecuted in the proper courts of the United States, without delay, for the enforcement of the penalties as in such case herein provided.

Sec. 6. That the term 'drug,' as used in this act, shall include all medicines and preparations recognized in the United States Pharmacopeia or National Formulary for internal or external use, and any substance or mixture of substances intended to be used for the cure, mitigation, or prevention of disease of either man or other animals. The term 'food,' as used herein, shall include all articles used for food, drink, confectionery, or condiment by man or other animals, whether simple, mixed, or compound.

Sec. 7. That for the purposes of this act an article shall be deemed to be adulterated—

In case of drugs:

First. If, when a drug is sold under or by a name recognized in the United States Pharmacopeia or National Formulary, it differs from the standard of strength, quality, or purity, as determined by the test laid down in the United States Pharmacopeia or National Formulary official at the time of investigation: *Provided,* That no drug defined in the United States Pharmacopeia or National Formulary shall be deemed to be adulterated under this provision if the standard of strength, quality, or purity be plainly stated upon the bottle, box, or other container thereof, although the standard may differ from that determined by the test laid down in the United States Pharmacopeia or National Formulary.

Second. If its strength or purity fall below the professed standard or quality under which it is sold.

In the case of confectionery:

If it contains terra alba, barytes, talc, chrome yellow, or other mineral substance or poisonous color or flavor, or other ingredient deleterious or detrimental to health, or any vinous, malt, or spirituous liquor or compound or narcotic drug.

In the case of food:

First. If any substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength.

Second. If any substance has been substituted wholly or in part for the article.

Third. If any valuable constituent of the article has been wholly or in part abstracted.

Fourth. If it be mixed, colored, powdered, coated, or stained in a manner whereby damage or inferiority is concealed.

Fifth. If it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health: *Provided,* That when in the preparation of food products for shipment they are preserved by any external application applied in such manner that the preservative is necessarily removed mechanically, or by maceration in water, or otherwise, and directions for the removal of said preservative shall be printed on the covering or the package, the provisions of this act shall be construed as applying only when said products are ready for consumption.

Sixth. If it consists in whole or in part of a filthy, decomposed, or putrid animal or vegetable substance, or any portion of an animal unfit for food, whether manufactured or not, or if it is the product of a diseased animal, or one that has died otherwise than by slaughter.

SEC. 8. That the term 'misbranded,' as used herein, shall apply to all drugs, or articles of food, or articles which enter into the composition of food, the package or label of which shall bear any statement, design, or device regarding such article, or the ingredients or substances contained therein which shall be false or misleading in any particular, and to any food or drug product which is falsely branded as to the state, territory, or country in which it is manufactured or produced.

That for the purposes of this act an article shall also be deemed to be misbranded:

In case of drugs:

First. If it be an imitation of or offered for sale under the name of another article.

Second. If the contents of the package as originally put up shall have been removed, in whole or in part, and other contents shall have been placed in such package, or if the package fail to bear a statement on the label of the quantity or proportion of any alcohol, morphin, opium, cocain, heroin, alpha or beta eucain, chloroform, cannabis indica, chloral hydrate, or acetanilid, or any derivative or preparation of any such substances contained therein.

In the case of food:

First. If it be an imitation of or offered for sale under the distinctive name of another article.

Second. If it be labeled or branded so as to deceive or mislead the purchaser, or purport to be a foreign product when not so, or if the contents of the package as originally put up shall have been removed in whole or in part and other contents shall have been placed in such package, or if it fail to bear a statement on the label of the quantity or proportion of any morphin, opium, cocain, heroin, alpha or beta eucain, chloroform, cannabis indica, chloral hydrate, or acetanilid, or any derivative or preparation of any such substances contained therein.

Third. If in package form and the contents are stated in terms of weight or measure, they are not plainly and correctly stated on the outside of the package.

Fourth. If the package containing it or its label shall bear any statement, design, or device regarding the ingredients or the substances contained therein, which statement, design, or device shall be false or misleading in any particular: *Provided,* That an article of food which does not contain any added poisonous or deleterious ingredients shall not be deemed to be adulterated or misbranded in the following cases:

First. In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food, under their own distinctive names, and not an imitation of or offered for sale under the distinctive name of another article, if the name be accompanied on the same label or brand with a statement of the place where said article has been manufactured or produced.

Second. In the case of articles labeled, branded, or tagged so as to plainly indicate that they are compounds, imitations, or blends, and the word 'compound,' 'imitation,' or 'blend,' as the case may be, is plainly stated on the package in which it is offered for sale: *Provided,* That the term 'blend' as used herein shall be construed to mean a mixture of like substances, not excluding harmless coloring or flavoring ingredients used for the purpose of coloring and flavoring only: and *Provided, further,* That nothing in this act shall

be construed as requiring or compelling proprietors or manufacturers of proprietary foods which contain no unwholesome added ingredients to disclose their trade formulas, except in so far as the provisions of this act may require to secure freedom from adulteration or misbranding.

Sec. 9. That no dealer shall be prosecuted under the provisions of this act when he can establish a guaranty signed by the wholesaler, jobber, manufacturer or other party residing in the United States, from whom he purchases such articles, to the effect that the same is not adulterated or misbranded within the meaning of this act, designating it. Said guaranty, to afford protection, shall contain the name and address of the party or parties making the sale of such articles to such dealer, and in such case said party or parties shall be amenable to the prosecution, fines and other penalties which would attach, in due course, to the dealer under the provisions of this act.

Sec. 10. That any article of food, drug or liquor that is adulterated or misbranded within the meaning of this act, and is being transported from one state, territory, district or insular possession to another for sale, or, having been transported, remains unloaded, unsold or in original unbroken packages, or if it be sold or offered for sale in the District of Columbia or the territories or insular possessions of the United States, or if it be imported from a foreign country for sale, or if it is intended for export to a foreign country, shall be liable to be proceeded against in any district court of the United States within the district where the same is found, and seized for confiscation by a process of libel for condemnation. And if such article is condemned as being adulterated or misbranded, or of a poisonous or deleterious character, within the meaning of this act, the same shall be disposed of by destruction or sale, as the said court may direct, and the proceeds thereof, if sold, less the legal costs and charges, shall be paid into the treasury of the United States, but such goods shall not be sold in any jurisdiction contrary to the provisions of this act or the laws of that jurisdiction: *Provided, however,* That upon the payment of the costs of such libel proceedings and the execution and delivery of a good and sufficient bond to the effect that such articles shall not be sold or otherwise disposed of contrary to the provisions of this act or the laws of any state, territory, district or insular possession, the court may by order direct that such articles be delivered to the owner thereof. The proceedings of such libel cases shall conform, as near as may be, to the proceedings in admiralty, except that either party may demand trial by jury of any issue of fact joined in any such case, and all such proceedings shall be at the suit of and in the name of the United States.

Sec. 11. The Secretary of the Treasury shall deliver to the Secretary of Agriculture, upon his request, from time to time, samples of foods and drugs which are being imported into the United States or offered for import, giving notice thereof to the owner or consignee, who may appear before the Secretary of Agriculture and have the right to introduce testimony, and if it appear from the examination of such samples that any article of food or drug offered to be imported into the United States is adulterated or misbranded within the meaning of this act, or is otherwise dangerous to the health of the people of the United States, or is of a kind forbidden entry into, or forbidden to be sold or restricted in sale in the country in which it is made or from which it is exported, or is otherwise falsely labeled in any respect, the said article shall be refused admission, and the Secretary of the Treasury shall refuse delivery to the consignee and shall cause the destruction of any goods refused delivery which shall not be exported by the consignee within three months from the date of notice of such refusal under such regulations as the Secretary of the Treasury may prescribe: *Provided,* That the Secretary of the Treasury may deliver to the consignee such goods pending examination and decision in the matter on execution of a penal bond for the amount of the full invoice value of such goods, together with the duty thereon, and on refusal to return such goods for any cause to the custody of the Secretary of the Treasury, when demanded, for the purpose of excluding them from the country, or for any other pur-

pose, said consignee shall forfeit the full amount of the bond: and *Provided, further,* That all charges for storage, cartage and labor on goods which are refused admission or delivery shall be paid by the owner or consignee, and in default of such payment shall constitute a lien against any future importation made by such owner or consignee.

SEC. 12. That the term 'territory,' as used in this act, shall include the insular possessions of the United States. The word 'person,' as used in this act, shall be construed to import both the plural and the singular, as the case demands, and shall include corporations, companies, societies and associations. When construing and enforcing the provisions of this Act, the act, omission or failure of any officer, agent or other person acting for or employed by any corporation, company, society or association, within the scope of his employment or office, shall in every case be also deemed to be the act, omission or failure of such corporation, company, society or association as well as that of the person.

SEC. 13. That this act shall be in force and effect from and after the first day of January, 1907.

SCIENTIFIC NOTES AND NEWS.

SIR DAVID GILL, H. M. astronomer at the Cape of Good Hope, will succeed Dr. E. Ray Lankester, director of the British Museum of Natural History, as president of the British Association for the Advancement of Science.

A KNIGHTHOOD has been conferred on Dr. W. H. Perkin, F.R.S., the jubilee of whose discovery of the aniline dye mauve has recently been celebrated.

SIR JAMES DEWAR, Jacksonian professor of experimental philosophy at Cambridge University and Fullerian professor of chemistry at the Royal Institution, has received the Matteucci medal of the Italian Society of Sciences.

DR. A. E. DOLBEAR, since 1874 professor of physics at Tufts College, has retired from active service under the provisions of the Carnegie Foundation.

DR. A. G. RUTHVEN has been appointed curator of the Museum of the University of Michigan. He is spending the summer in Texas, New Mexico and Arizona, collecting reptiles and studying their field relations for the American Museum of Natural History.

DR. ALBERT ERNEST JENKS, formerly the chief of the Ethnological Survey of the Philippine Islands, has been engaged in the cataloguing of the Philippine ethnological collection, purchased by the American Museum of Natural History at the St. Louis Exposition.

WE learn from the London *Times* that at a meeting of the master and fellows of Christ's College, Cambridge, held on July 20, Mr. Francis Darwin was elected honorary fellow, and Dr. G. H. F. Nuttall, F.R.S., fellow of the society. Mr. Darwin is foreign secretary of the Royal Society. He was educated at Trinity College and for many years was reader in botany in the university and fellow of Christ's. Dr. Nuttall, who has held teaching posts at Johns Hopkins University and at the University of Berlin, is now reader in hygiene at Cambridge. He is the chief editor of the *Journal of Hygiene.*

DR. A. L. CRAMPTON, of Maryland, has been made chief of a division of the Bureau of Internal Revenue, established to carry out the provisions of the denatured alcohol act. Internal Revenue Commissioner Yerkes is in Europe making an inquiry into the operations of denatured alcohol laws in England, Germany and Holland.

PROFESSOR H. M. SAVILLE, of Columbia University and the American Museum of Natural History, is this summer carrying on explorations in Ecuador and Colombia.

DR. AUGUSTINE HENRY, known for his botanical researches in China and elsewhere, is at present in the United States, with a view to studying forestry conditions.

PROFESSOR SOLLAS, of Oxford University, assisted by Professor Lugeon, has conducted a party of students on a geological trip through the Alps.

THE department of vertebrate paleontology of the American Museum of Natural history has three expeditions in the field this season. Mr. Barnum Brown is continuing the search

for dinosaurs in the Cretaceous beds of Montana; Mr. Walter Granger is searching for fossil mammals in the Eocene formations of Wyoming, and Mr. Albert Thomson is exploring the later Tertiary formations of South Dakota.

Mr. Almon Harris Thompson, geographer of the U. S. Geological Survey since 1882, and previously in charge of geographic work under Major Powell, died at Washington, on July 31, at the age of sixty-seven years.

Mr. Joseph H. Batty, a well-known natural history collector and taxidermist, was killed by the accidental discharge of his gun, while on an expedition in Mexico for the American Museum of Natural History.

Sir Walter Buller, F.R.S., of Wellington, New Zealand, the author of important contributions to ornithology, died on July 19, at the age of sixty-eight years.

The underground water investigations will be conducted by the United States Geological Survey in the eastern United States as usual this summer, notwithstanding the reduction of the hydrographic appropriation by congress. Work is under way in Maine, Connecticut, Virginia, Florida, Kentucky, Ohio, Indiana and Iowa, and will be extended to New York, Pennsylvania, North Carolina, South Carolina and Minnesota later in the season. Mr. M. L. Fuller will supervise the investigations in the states mentioned.

Lord Selby will act as chairman of a Royal Commission which is to be appointed to consider the subject of experiments on living animals and the law relating thereto. Since the passing of the cruelty to animals act of 1876, no inquiry into its working has been held. The terms of the commission's reference will be "to inquire into and report upon the practise of subjecting live animals to experiments, whether by vivisection or otherwise; and also to inquire into the law relating to that practise and its administration, and to report whether any, and if so what, changes are desirable."

Nature states that the Natural History Museum has just received an important collection of bird and mammal skins from Mount Ruwenzori, East Central Africa, obtained with the aid of subscriptions from a number of persons interested in natural history. The collection is said to include a number of new forms, or of forms previously known only by a single specimen or so of each.

Plans have been filed in New York for a new museum to be built on Audubon Park Terrace, on 155th St., west of Broadway, for the American Numismatic and Archeological Society, of which Mr. Archer M. Huntington is president. The edifice will be 39.8 feet front and 63.3 feet deep, of concrete construction. It will be three stories in the classic style, with Ionic columns. The main floor and the second story will be devoted to the library and the meeting halls and exhibition galleries. The building is to cost $55,000.

The foundation has been laid for the building of a new Bacteriological Institute at Constantinople, intended especially to provide anti-toxic sera to the Turkish empire.

We learn from *Nature* that Mr. G. Montefiore-Levi, of Brussels, formerly a member of the Belgian senate and president of the Association of Engineers, has bequeathed a portion, probably exceeding £100,000 in value, of his residuary estate, to be applied for the prevention of consumption.

A press despatch from Washington reports that negotiations have been in progress for some time in London between the American embassy and the British Foreign Office relative to the protection of the seal herd in Bering Sea. Several years ago congress authorized the wholesale killing of all the seals on the Pribiloff Islands rookeries unless some arrangement could be made with the British government for the prevention of pelagic sealing. The award of the arbitrators in the Bering Sea case prescribing closed zones around the Pribiloff Islands, and a close season in the seal waters has completely failed to meet the needs of the case, hence the direction of congress. There has been some desultory correspondence between the governments at Washington and London for several years, but only recently has the matter been taken up in

earnest, and it is now believed that the embassy has succeeded in reaching a working agreement with the British government on a plan for the protection of seals, though the details remain to be developed. In the absence of exact information as to the scope of the agreement, it is believed here that its basis is a provision for the total suspension of sealing operations in Bering Sea for a term of years.

THE U. S. Civil Service Commission announces an examination on August 29, to secure eligibles from which to make certification to fill a vacancy in the position of chemist, Bureau of Science, Manila, P. I., at $1,500 per annum, and vacancies as they may occur in the Philippine Service requiring similar qualifications. It will not be necessary for applicants to appear at any place for examination. Their eligibility for the position will be determined upon the evidence furnished concerning their education, training and experience. It is desired to secure the services of a young man, energetic and capable, who has had several years of university training in a first-class institution, and this training should include a thorough foundation in all lines of the science, such as can be obtained by persons specializing in chemistry at any one of the first-class schools which make a specialty of giving chemical training. His main training should be in organic chemistry. The work required is of a routine nature and covers analytical methods and results, and the person appointed must be accurate and careful and he should have a good technique. There are in the bureau, however, other chemical positions which are practically for purposes of research. There is a considerable number of positions the salaries of which range from $1,600 to $2,250 per annum, and even higher, so that the person appointed to the position for which this examination is held, if he proves himself capable of filling higher positions, will have promotions open to him as rapidly as vacancies occur, and it is stated that such vacancies will not be too long delayed. The person appointed must not only have the ability and technique, but he must have ambition to push his work in every way possible and to keep abreast of literature. The laboratory is thoroughly equipped for all classes of chemical work.

MR. F. G. CLAPP, of the United States Geological Survey, has been engaged for several months in a study of the underground waters of the State of Maine, including both those in indurated rocks and in the drift. The investigation, which is now nearly completed, has brought out many points of interest in regard to the drift and has established the existence of deposits of several glacial and interglacial stages, including the equivalent of: (1) The supposed pre-Kansan till described by Fuller in southeastern Massachusetts, (2) the Jameco gravels (Kansan ?) found by Veatch and Fuller on Long Island, Marthas Vineyard, Cape Cod, etc., (3) the Montauk till (Illinoian ?) noted by Fuller on Long, Fishers and Block Islands, and in the drumlins about Boston, (4) Manhasset gravels described by Woodworth on Long Island, (5) the thick clays and overlying sands (Iowan ?) of southern Maine, (6) sands and tills of the latest ice invasion. Marked unconformities occur between beds 4 and 5 and between beds 5 and 6. There are indications that a still further subdivision of the drift may be possible.

UNDER the supervision of Mr. C. R. Van Hise, geologist of the United States Geological Survey, in charge of the section of pre-Cambrian and metamorphic geology, an economic investigation of iron ore deposits in Utah, Colorado and the Lake Superior region will be conducted during the coming year. Mr. Van Hise will be assisted by Messrs. C. K. Leith, E. C. Harder, F. Ward, A. C. Deming and W. Toellner. The mapping of the iron ores of the Iron Springs Special quadrangle of southern Utah was completed on July 1. A special topographic map on a scale of 1:45000, with 50-foot contour intervals has been made of an area of 225 square miles. The ore deposits themselves were mapped on a still larger scale of 250 feet to the inch. The maps and the report on the district will be published during the coming winter. This work was directed by Mr. C. K. Leith, who

was assisted by Messrs. E. C. Harder, F. J. Katz and Freeman Ward. On July 1, this same party took up the detailed mapping of the iron ores at Ashcroft in Pitkin and Gunnison counties and at White Pine in Gunnison County, Colo. These deposits are similar in character and geologic relationships to those already mapped in southern Utah. Study of them will aid in solving the general problem of the origin of the western iron ores. These deposits are also especially interesting, because they are likely to be of considerable commercial importance. It is hoped that during the year the final general monograph on Lake Superior geology, which Messrs. Van Hise and Leith have in hand, will be completed.

UNIVERSITY AND EDUCATIONAL NEWS.

The General Education Board, endowed by Mr. John D. Rockefeller with $10,000,000, has made appropriations to nine institutions on condition that three times the sum be appropriated from other sources. The appropriations, which amount to $312,500, are as follows: Coe College, Cedar Rapids, Ia., $50,000; Washburn College, Topeka, Kan., $25,000; Tulane University, New Orleans, $75,000; Wofford College, Spartanburg, S. C., $25,000; Furman University, Greenville, S. C., $25,000; Wake Forest College, Wake Forest, N. C., $37,500; Howard College, Birmingham, Ala., $25,000; Southwestern University, Jackson, Tenn., $25,000, and Mississippi College, Clinton, Miss., $25,000.

The late Dr. James Stewart, of Herts, has bequeathed about $135,000 to the University of Melbourne for a scholarship in anatomy, medicine and surgery, and an equal sum to other educational institutions in Melbourne.

We learn from the *Journal of the American Medical Association* that the new laboratory building for the use of the College of Medicine and Surgery, University of Minnesota, and the State Board of Health, will be ready for work at the beginning of the school year in September. The building is fireproof, and 60 by 213 feet. Plans are also being prepared for a building for operative surgery and experimental pharmacy, and for the new university hospital, made possible by the recent bequest of $150,000 by the late Dr. A. F. Elliott. Beginning with the college year 1907–08, the entrance requirement to the medical department will be two full years of college work. For several years the requirement for entrance has been one year of college work, but in view of the fact that nearly 60 per cent. of the present student body have had two or more years' college preparation, the regents felt justified in thus raising the standard for entrance.

Professor Norman Smith, of Glasgow University, has accepted a call to the Stuart professorship of psychology, Princeton University.

Dr. Warner Fite, adjunct professor of philosophy at the University of Texas, has been appointed junior professor of philosophy at Indiana University.

Professor R. B. Wylie, of Sioux City, Ia., resigns his position as professor of biology in Morningside College to become assistant professor of botany, in charge of morphology, at the State University of Iowa.

Miss Alice Robertson, Ph.D. (California), for the last two years assistant in zoology at the University of California, has accepted an instructorship in zoology at Wellesley College.

Dr. H. W. Marett Tims, demonstrator of anatomy in Cambridge University, has been appointed professor of biology at the Royal Veterinary College, London.

The Edinburgh University Court has appointed Dr. W. G. Smith, of Liverpool University, to the recently instituted George Combe lectureship in general and experimental psychology.

Professor F. S. Boulger has accepted the post of honorary professor of natural history and external examiner for the diploma at the Royal Agricultural College, Cirencester, in succession to the late Dr. Fream.

The electors to the Linacre professorship of comparative anatomy at Oxford University, vacant by the death of Professor Weldon, have elected to the chair Dr. Gilbert C. Bourne, fellow and tutor of New College, and university lecturer in comparative anatomy.

SCIENCE

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THE ITHACA MEETING OF THE AMERICAN CHEMICAL SOCIETY. I.

THE thirty-fourth general meeting of the American Chemical Society met in the chemical laboratory of Cornell University, at Ithaca, N. Y., on June 28–30. The society met partly in general session and partly in sections as follows:

Inorganic Chemistry: L. M. Dennis, chairman.

Organic Chemistry: G. B. Frankforter, chairman.

Physical Chemistry: W. Lash Miller, chairman.

Industrial Chemistry: J. D. Pennock, chairman.

Biological Chemistry: Waldemar Koch, chairman.

Agricultural and Sanitary Chemistry: E. B. Voorhees, chairman.

On Thursday evening there was a complimentary smoker given to the society by the Town and Gown Club. On Friday afternoon the members of the society attended the dedication of the Rockefeller Physical Laboratory. Following this, they left for an excursion to a hotel on Cayuga Lake, where dinner was served at 7:30. On Saturday morning Dr. E. Haanel, of the Department of Mines, Ottawa, Canada, gave an address on 'Electric Smelting Experiments at Sault Ste. Marie.' One hundred and thirty-two members of the society were in attendance on the meeting, which was a most enjoyable and successful one. The following are abstracts of papers which were presented:

GENERAL SESSION.

AFTER a brief address of welcome by Dean T. F. Crane and a response by President W. F. Hillebrand for the society, the following addresses were given:

The Terpenes and Colophonium with Some of Their Industrial Chemical Problems: G. B. FRANKFORTER.

The author in cooperation with students has been studying the terpenes and colophonium for a number of years. The pine family of the north and west has been

studied both from the strictly chemical and from the industrial standpoints. Large numbers of analyses of the wood of the Norway pine and the Douglas fir as to the amount of both the terpenes and colophonium were made. The stumps and roots of these species were likewise exhaustively studied. A chemical examination of the terpenes indicated that the common terpene present differed from the pinene of the southern pine, the boiling-point being lower, the optical properties and the compounds formed being different. A new series of compounds, the chlor-hydrochlorides, has been made both from the terpenes above mentioned and from common pinene. The colophonium from both the Norway pine and the Douglas fir has been shown to consist of two different acids. These acids are being carefully studied.

Harcourt and Esson's Method in Chemical Mechanics: W. Lash Miller.

As the rate of a chemical change in a homogeneous solution depends on the temperature and on the concentrations of the dissolved substances, measurements of the rate are best made in solutions whose temperatures are kept constant by means of a thermostat and in which the concentrations are kept constant by dissolving quantities large in comparison with those generated or destroyed during the reaction. In 1866 Harcourt and Esson measured rates of change in solutions containing a large excess of each of the reagents but one. Although they pointed out the advantages of this method of working, their example was not followed. Hood, in 1878, used in excess each but two of the reagents; van't Hoff ('Études,' 1884) used equivalent quantities and compared the results of experiments with different initial concentrations; while from 1885 to 1895 it was the custom to work with more or less equivalent concentrations and to deduce the 'order' of the reaction from a series of analyses. By this time the method of Harcourt and Esson was forgotten. In 1895 A. A. Noyes resuscitated van't Hoff's method; in 1901 Ostwald proposed a method which somewhat resembles Harcourt's; and in the same year Harcourt and Esson's way of working was revived in the laboratory of the speaker, where the principles of the method have been extended (method of constant rates) and applied to the study of chemical equilibrium (arsenic and iodine). The power of Harcourt and Esson's method as a tool of research was illustrated by a number of examples.

Some Problems for Agricultural Chemists: E. B. Voorhees.

This paper is historical and suggestive, rather than containing the results of definite experiments. It points out the conditions heretofore existing in this country, which have encouraged agricultural chemists to demonstrate the principles already understood, rather than to investigate. Notwithstanding the larger use of commercial fertilizers in the east, and better farming methods in the west, there is an apparent exhaustion of soils, which calls for scientific investigation of those problems connected with the soil and its fertility.

The nitrogen question is supreme, notwithstanding the discoveries that have recently been made, in reference to both the symbiotic appropriation of nitrogen, and its abstraction from the air by electric means.

The Occurrence of Boracic Acid in Death Valley, California, and in Tuscany: Edward Hart.

This was a description of two trips, one to Death Valley in 1902–3 and one to the soffoni of Tuscany in May, 1906. The boric acid occurs near Daggett, California, as colemanite, $Ca_2B_6O_{11}$, and as calcium

borate in borate mud. The colemanite is sent to Bayonne, N. J., and converted into borax. The borate mud is treated at Daggett with sulphur dioxid and the boric acid crystallized out and shipped. In Tuscany the boric acid vapors are passed into water which is then evaporated. The vapors from driven wells have a pressure sometimes of nine atmospheres and after purification are used for driving steam-ngines. Nearly pure ammonium sulphate is also produced.

AGRICULTURAL AND SANITARY CHEMISTRY.

E. B. Voorhees, chairman.

The Improved Refractometer Slide Rule and its Application: ALBERT E. LEACH and HERMANN C. LYTHGOE.

The refractometer slide rule was first described in the *Jour. Am. Chem. Soc.*, in 1904. Since then it has been somewhat improved and is now on the market. It is designed for the use of oil and food chemists who have occasion to employ the butyro or the Abbé refractometer. It readily converts indices of refraction (which the Abbé instrument reads directly) into degrees on the butyro-refractometer, and *vice versa*. It also enables one to transfer scale readings or refractive indices taken at any temperature into their equivalent at any other, thus avoiding troublesome calculations.

Comparative Effect of Organic and Mineral Matter in Soil-extract Cultures: OSWALD SCHREINER.

A series of experiments with wheat and other seedlings is reported in which the effect of the organic and inorganic constituents of the soil solution and of organic manures are studied. It is shown that the toxic effect of certain soil extracts is not entirely overcome by fertilizer salts, but is more markedly affected by organic substances, such as pyrogallol, the organic matter from ordinary stable manure, etc., as well as by treatment with certain other non-nutrient substances, or even by mere boiling of the extract, indicating the presence of volatile or thermolabile organic substances. Results are obtained by separating the organic and inorganic portions of a stable manure extract and studying the effect of the various fractions on wheat seedlings. The results show that the organic substances play a very large part in the effectiveness of the extract, and more especially through an action other than that of nutrition.

Chemical and Bacteriological Factors in the Ammonification of Soil Nitrogen: JACOB G. LIPMAN.

It is well known that organic nitrogen, either as applied in manures and fertilizers, or as forming a part of the soil humus, is utilized to an unequal extent in different soils. Since the crops growing on any soil do not derive their nitrogen food directly from the nitrogenous organic compounds, but make use of them only after they are changed into more simple substances in the processes of decay, it follows that the unequal utilization of the organic nitrogen, in different soils, is intimately related to the quantitative and qualitative differences in the development of certain classes of soil organisms. On the other hand, the soil bacteria are themselves influenced in their growth by the chemical and physical constitution of the soil; and the simplification of organic compounds in arable lands is, therefore, a function of both chemical and bacteriological activities. It is shown that when 100 c.c. of a ten per cent. solution of peptone is inoculated with ten grams of fresh soil the rapid transformation of the peptone nitrogen takes place. On distillation with excess of magnesia a large portion of this peptone nitrogen distils over as ammonia.

The amount of ammonia depends on the nature of the soil. The question arises as to the reason why one soil will lead to the formation of more ammonia than another soil under the same conditions. Are the differences due to the numbers or kind of bacteria or are they due to variations in the chemical composition of the soil? Experiment has demonstrated that the bacteriological factor has been found to play the predominant rôle in the ammonification of soil nitrogen and that it is itself directly affected by the chemical composition of the soil.

The detailed results of these studies will be reported in the *Journal of the American Chemical Society.*

Composition of the Drainage Waters of Some Alkali Tracts: F. K. Cameron.

It was shown how the analysis of a drainage water could be used in interpreting the changes taking place in alkali soils under drainage. Illustrations were given, on the one hand, showing that the same salts present in the soil remain, though the total amount had been diminished, and on the other hand, illustrations were given where not only the amount of salts, but the particular kinds of salts, had changed.

Nutrition Investigation of the Office of Experiment Stations, and the Results of Some Recent Work: C. F. Langworthy.

The purpose and scope of the human nutrition investigation carried on under the auspices of the Office of Experiment Stations of the Department of Agriculture, were briefly outlined, particularly the work of the fiscal year 1905–6, and the results of some dietary studies with aged men and women were summarized. From the data presented and a summary of similar work, the factor nine tenths was proposed as representing the amount consumed by a man past middle life, as compared with a man in full vigor at moderate muscular work.

Keeping of Tobacco: J. M. Bell.

This article has been published in full in Science, June 16, 1906.

A Method for the Determination of the Lead Number in Maple Syrups and Maple Sugar: A. L. Winton and J. Lehn Kreider.

The method proposed is based on the well-known fact that lead subacetate produces a voluminous precipitate in genuine maple products, whereas in products adulterated with refined cane sugar the amount is deficient. A solution of 25 grams of the material is precipitated with 25 c.c. of standard lead subacetate, made up to 100 c.c., filtered, and the lead determined in 10 c.c. of the filtrate. The amount of lead consumed in forming the precipitate is found by difference. This expressed as per cent. of the material is the 'lead number.' The lead number in samples of maple syrups of known purity was not less than 1.20, but in adulterated samples it ranged from 0.02 to 0.92.

The Application of Colorimetric and Other Delicate Analytical Methods to the Study of Agricultural Problems: Ostwald Schreiner and J. F. Breazeale. (By title.)

Legume Bacteria and Soil Fertility: Karl Kellerman. (By title.)

Toxicity of Some Ammonium Salts on Wheat Seedlings in Solution Cultures: Charles A. Jensen. (By title.)

A Preliminary Study of the Combinations of Acids with Casein as determined by Conductivity Measurements: L. L. Van Slyke.

For more than half a century there has been at issue a question as to whether or not the coagulum formed when milk sours or is acted on by acids is a combination of casein and acid. As the result of work carried on in the Geneva Station Labora-

tory by Mr. E. B. Hart and myself satisfactory evidence was produced to show that casein can and does combine with acids to form insoluble casein salts. An attempt was made to settle the quantitative side of the question by suspending free casein in a given amount of dilute acid of known strength, filtering and determining the amount of acid left uncombined. This method was found to be inadequate. It then occurred to the writer that results might be obtained by suspending free casein in dilute acid and then testing the filtrate for changes of electrical conductivity. This work is being done largely by Mr. Donald D. Van Slyke.

The conductivity method shows that the base-free casein forms an insoluble compound with dilute hydrochloric acid, which slowly combines with more acid forming a soluble compound. This soluble compound forms more readily with more concentrated acid and is unstable, being readily decomposed by bases with precipitation of a compound probably pure casein. Further the conductivity method shows that the amount of acid combined with casein is considerably in excess of that found by the method first used and that the low results are accounted for by the formation of this soluble compound.

The work is still unfinished and many other phases will be studied.

Movement of Water and Solutions in Soils: F. K. CAMERON and J. M. BELL.

It has been pointed out in Bulletin 30, Bureau of Soils, that the movement of water in capillary media is described by the empirical formula,

$$y^n = Kt.$$

Further experiments show that in case of the movement of water through a capillary tube n is equal to 2. A theoretical deduction of this formula has been given.

Relation of Sodium to Potassium in Soil and Solution Cultures: J. F. BREAZEALE. (By title.)

The Distribution of Soluble Bodies between Water and Soils, or other Finely-divided Solids: F. K. CAMERON and H. E. PATTEN.

It has been shown that the rate of absorption generally follows the law expressed by the equation

$$\frac{dy}{dt} = K(C - y),$$

which is the equation describing a reaction of the first order. The distribution of substances, both organic and inorganic, between a soil or other absorbing material and the solvent was studied, and it was found in a majority of cases that the curves were of a logarithmic character, which appears to be expressed by the empirical formula,

$$\log \frac{y}{C - y} = K_x.$$

Several cases were found, however, which were better expressed by a linear equation. It was shown that the soils and other absorbing media have a maximum saturation capacity, C in the above formula, which has an important significance from an agricultural point of view.

Abnormal Transpiration in relation to Growth in Wheat under Certain Conditions: OSWALD SCHREINER and CHARLES A. JENSEN. (By title.)

Superphosphates: F. K. CAMERON and J. M. BELL.

In the four-component system—lime, sulphuric acid, phosphoric acid, water, which are the essential constituents of superphosphates—five stable solids have been found at 25°, viz., monocalcium phosphate, dicalcium phosphate, anhydrite, gypsum and a series of solid solutions in phosphoric acid and lime. The inversion points and

the boundary lines of the fields have been determined. At 66°, however, the field for gypsum disappears. From these data there was shown the effect of leaching superphosphates by water at ordinary temperatures.

A Simple Fat-extraction Apparatus: G. S. Fraps.

The apparatus uses a mercury joint, and is simple and cheap.

Flavoring Extracts, Natural and Artificial, in Food Products: Edward Gudeman. (By title.)

A Colorimetric Method for the Determination of Absorbed Oxygen in Water: G. B. Frankforter and A. D. Wilhoit.

The importance attached to the amount of absorbed oxygen in a sanitary analysis of water led the authors to search for a colorimetric method which would be in line with sanitary methods in general, and which would at the same time be rapid and accurate. A method using cuprous ammonium chloride was finally adopted. The advantages of the method, however, are largely in the construction of the apparatus. After various oils and even perfect rubber stoppers were found to be inefficient in protecting the colorless cuprous ammonium chloride from oxidation by air, a special glass stopper was devised. This stopper with a siphon was fitted into the top of one of the Hehner cylinders so as to protect the water in the tube from the air and at the same time to be used as a colorimeter by making comparisons in the ordinary way. The manipulation is very simple. The glass cork is placed in the Hehner cylinder so that the lower end stands at 101 c.c. Then 100 c.c. of water under examination is allowed to flow in. By turning a three-way stop-cock 1 c.c. of cuprous ammonium chloride is added, when a blue color immediately appears depending in intensity upon the amount of free oxygen in the water. The color is matched in the second Hehner cylinder by cupric ammonium chloride of known strength and representing a known quantity of oxygen. With this apparatus very rapid and accurate determinations are possible.

The Estimation of Citral in Lemon Oil: E. Mackay Chace. (By title.)

ORGANIC CHEMISTRY.

G. B. Frankforter, chairman.

The Fruit of Smilacina racemosa and trifolia: Nicholas Knight.

The purpose of the work was, as far as possible, to determine the composition of the fruit. The berries were gathered between August 15 and September 5, 1905, at Sylvan Beach, N. Y., on the shore of Oneida Lake. They were allowed to ripen in the house. At first they were green in color and the fruit of the *racemosa* were about the size of peas, the fruit of the *trifolia* being smaller. As they ripened both species became of a reddish color, resembling currants. The *racemosa* fruit contains free tartaric and a small quantity of citric acid, a red coloring matter and glucose. The nutlets or kernels were ground and digested with boiling alcohol, by which an oil or possibly two oils were received. These were investigated. The fruit of the *trifolia* showed a similar composition, the main difference being potassium tartrate in place of the free tartaric acid.

The Constitution of Paris Green and its Homologues: S. Avery.

The writer shows by a review of the literature that great uncertainty exists in regard to the constitution of these substances. Many years ago Ehrmann found that a commercial sample of Paris green (Schweinfurt green) consisted of three molecules of copper meta-arsenite in chemical combination with one molecule of cop-

per acetate. Later Wöhler made a green starting with copper butyrate and found the ratio to be 2:1. The writer shows that Paris green and its homologues may be regarded as isomorphic crystalline mixtures in which the extreme limits of the ratio of copper arsenite to the copper organic acid salt lie between 3:1 and 2:1. This view is confirmed by the study of greens, samples of which have been made containing a great diversity of organic acids. It is further confirmed by a study of certain zinc arsenites.

A Chemical Study of Curare: G. B. FRANKFORTER and H. M. NEWTON.

The authors have made an exhaustive examination of the various forms of curare, or arrow poison. It required several years to collect these samples in the crude form as prepared by the Indians. On one or two occasions the bulbs or original containers had been partly filled with sand by the Indians, only a small amount of the alkaloid having been placed on the top of the sand. The analyses of these samples varied widely in composition. The amount of inorganic matter varied from 15 to 68 per cent., and in one or two cases the substance was found to be perfectly inert, physiologically. Reactions indicated an alkaloid with marked basic properties. No crystallized compounds were made, but analyses of the base prepared from the platinum double salts indicated that the formula for the alkaloid, notwithstanding the fact that it is used extensively as a medicine at the present time, is still in doubt. The formula given for the free base by Sachs was obtained from an analysis of the platinum double salt. The formula of Preyer has been shown to be incorrect, as the material analyzed contains a large amount of inorganic matter. From the work already done, the authors conclude that the free base in curare or curarine is more complex than the formula given by Sachs.

PHYSICAL CHEMISTRY.

W. Lash Miller, chairman.

Cooperation in Physical Chemistry: W. D. BANCROFT.

We could be of more assistance to each other if we had a system of reports by which we knew what bits of research work the others were doing. Each one of us has stored away in his memory a number of generally unfamiliar facts which he has stumbled upon in his reading or in his laboratory. These may not be important enough to him to justify his doing enough work to get anything worth publishing, or he may have more important matters on hand and so lack the time. If now any one of us learns that any one of the others is doing a bit of investigation into which this, that, or the other fact fits nicely, the observation can at once be turned over to the man who can use it, much to the benefit of both parties.

It is probable that nobody goes to one of the meetings of the Chemical Society without getting a few suggestions of value to him. On the other hand, owing to the great distances and consequent expense, we do not get together as often as we should like. If we kept more in touch, we should be getting continually some of the advantages which we now get from the occasional meetings. The matter would not be difficult to arrange. In October and February each man could make out a list of the work planned or in operation. These reports could be manifolded and distributed. So far as I can see, the plan has practically no objectionable features and might be of great value. It seems therefore worth trying.

Uniformity in the Use of Algebraic Symbols: W. LASH MILLER.

The desirability of a uniform system of symbols for use in works on physical, chemical and engineering subjects has often been urged; and various systems have been suggested, one of them by a former president of this society.

The latest proposal, made by Linders in his pamphlet 'Die Formelzeichen,' Leipsic, 1905, is very ambitious, and involves the use of German and Russian type in addition to the Greek and Latin alphabets. Would it be more practical to divide the sciences into groups, and to fix on a uniform system of symbols for use in each group, without insisting that a letter to which one meaning has been assigned in geometry, for instance, should not be employed with another meaning in chemistry? Is it desirable to appoint a committee to consider the whole question and report at a subsequent meeting?

The Influence of Calcium on Iron: O. P. Watts. (By title.)

The Electrical Conductivity of Solutions of the Alcohols in Liquid Hydrobromic Acids: E. H. Archibald.

Qualitative tests were first made to see what classes of the alcohols would dissolve in this solvent to give conducting solutions. The liquid acid is found to be very selective as regards the bodies which it will dissolve, being a solvent for one alcohol but not for another, although they differ but little in constitution. The conductivities of solutions of some fourteen of the alcohol bodies have been measured quantitatively over a considerable range of dilution. In the case of the greater number of the solutions the temperature coefficients have also been determined. The molecular conductivity in nearly all cases increases rapidly with the concentration. In a few instances for the more dilute solutions of the simpler alcohols the molecular conductivity either decreases slightly with the concentration or remains practically constant. As far as these investigations have extended those bodies which dissolve conduct the electric current. The temperature coefficients are in some cases positive, in some cases negative.

The Electrical Conductivity of Solutions of the Organic Acids in Liquid Hydrobromic and Hydrochloric Acids: E. H. Archibald.

Qualitative tests of about twenty of the organic acids showed that quite a number would dissolve in both solvents to give conducting solutions. As far as can be ascertained those acids which dissolve to any extent give solutions which will conduct. The quantitative measurements show that the hydrochloric acid solutions have by far the greater conducting power, at least in the case of nearly all the bodies examined. The molecular conductivity for both solvents, except in a few cases for the very dilute solutions, increases with the concentration. The temperature coefficients in all the cases examined are positive.

The Identification of Insoluble Phases: L. F. Hawley.

By means of the solubility method the formula $2PbCO_3 . Pb(OH)_2$ for the basic carbonate of lead was confirmed. Mixtures of lead carbonate and oxide in varying proportions were treated with a 20 per cent. sodium acetate solution and the amount of lead dissolved in 50 c.c. was determined. The oxide was found to hydrate in the presence of the carbonate until sufficient hydroxide was formed to give $2PbCO_3 . Pb(OH)_2$. The solubility remained constant over a range of concentrations up to two molecules of the carbonate to one of the oxide, and with more than two of the carbonate to one of the oxide the solution was also constant, but at a lower value. This shows the presence of a compound with a formula corresponding to the

concentration at which the solubility changes.

Another method was used in the identification of the insoluble phases formed when thallium sulphide and stannic sulphide are precipitated together. Since the phases have different colors the appearance or disappearance of a phase can be readily observed under the microscope. From pure Tl_2S up to a concentration corresponding to Tl_4SnS_4 two phases can be distinguished, the black Tl_2S, and the red Tl_4SnS_4; from this point up to 76 per cent. SnS_2 two phases are present, the red Tl_4SnS_4 and a reddish yellow transparent phase, while beyond 76 per cent. SnS_2 all concentrations are homogeneous, showing a solid solution.

The Equilibrium between Ammonia and Hydrogen Sulphide: J. P. MAGNUSSON. The reaction

$$NH_3 + H_2S \rightleftarrows NH_4SH$$

was studied at 20° over a range of 95 cm. partial pressure. The mass-law formula

$$p_{NH_3} \times p_{H_2S} = \text{const.}$$

describes this equilibrium over the pressure range studied if the pressure of the undissociated NH_4SH is neglected and if corrections are made for the deviations of the gases from Boyle's law. For hydrogen sulphide this deviation was found to be within the limit of experimental error over the pressure range studied, but for ammonia the deviation was considerable at the higher pressures. This was shown to be due to the adsorption of the gas on the glass surface of the measuring tube and on the NH_4SH crystals. The adsorption of gases on the walls of the containing vessel has an important bearing on our conception of the so-called imperfect gases.

The Precipitation of Lead Chromate: EDWARD E. FREE.

Precipitations were made from equivalent solutions of $Pb(NO_3)_2$ and K_2CrO_4 under as nearly as possible equal conditions. The rapidity of precipitation is greater from hot solutions and more concentrated ones. The crystals are large when the solutions are hot and dilute. The presence of glue greatly retards precipitation. The color is apparently the same under all conditions of precipitation, provided the solutions are neutral. Alkali will impart an orange tinge due to basic chromate. Minor accidental variations in the manner of precipitation have a great influence.

Solubility of the Phosphates of Magnesium: F. K. CAMERON and J. M. BELL.

The behavior of calcium phosphates in contact with water and with phosphoric acid solutions has already been studied in this laboratory by Cameron, Seidell and Bell. It was found that at 25° only two calcium phosphates exist in equilibrium with aqueous solutions. At the higher concentrations monocalcium phosphate is the stable solid phase, and at intermediate concentrations dicalcium phosphate is the solid phase. At very low concentrations there is at least one series of solid solutions. The behavior of magnesium phosphates in contact with water and with phosphoric acid solutions has been studied in a similar way at 25° C. Here there are but two magnesium phosphates, the monomagnesium phosphate, which exists in contact with solutions containing above 700 grams of P_2O_5 per liter; below that concentration the stable solid is dimagnesium phosphate. The solution in contact with the above phosphates of calcium contains about 320 grams of P_2O_5 per liter, while that in contact with the phosphates of magnesium contains over 700 grams of P_2O_5 per liter.

The System Water-Gypsum-Lime: F. K. CAMERON and J. M. BELL.

The mutual solubility of gypsum in lime solutions and of calcium hydroxide in gypsum solutions has been determined at

25° C. The solubility of gypsum in lime solutions is depressed with increasing amounts of lime, while the solubility of lime in gypsum solutions shows very slight increases. The solution in contact with both calcium hydroxide and gypsum contains 1.59 grams $CaSO_4$ per liter and 1.22 grams of calcium hydroxide per liter. A solution containing calcium hydroxide alone contains 1.17 grams per liter and a solution containing gypsum carries 2.13 grams of calcium sulphate per liter. There is no basic sulphate of calcium at this temperature.

The Solubility of Gypsum in Phosphoric Acid Solutions: W. C. TABER.

The solubility of gypsum in several acids, notably hydrochloric, nitric and sulphuric, has already been studied. In this investigation of its solubility in phosphoric acid it was found that at 25° C. small amounts of phosphoric acid increase the solubility of gypsum to a marked extent, the solubility being greater as the concentration of the acid increases. At about 230 grams of P_2O_5 per liter there is a maximum solubility of about four times that in pure water. Above this concentration the solubility decreases regularly with increase of the acid content. The results of these experiments are in accord with other work on the solubility of gypsum in solutions of electrolytes which contain no ion in common with gypsum.

The Phosphates of Iron and Aluminum: F. K. CAMERON and J. M. BELL.

Crystalline phosphates of iron and of aluminum have been found to exist in solutions which contain high percentages of phosphoric acid. At lower percentages the precipitates appear to be solid solutions.

The Solubility of Nitric Oxide and of Air in Sulphuric Acid: O. F. TOWER.

The method of Bunsen was used, which consists in shaking the respective gas with sulphuric acid in a eudiometer tube, which is standing in a mercury bath.

The following are the results obtained:

Concentration of Sulphuric Acid.	Coefficient of Solubility In Nitric Oxide.	In Air.
98 per cent.	No constant results obtained.	0.0173
90 per cent.	0.0193	0.0107
80 per cent.	0.0117	0.0069
70 per cent.	0.0113	0.0055
60 per cent.	0.0118	0.0059
50 per cent.	0.0120	0.0076

These numbers are so small that the solubility of these gases in sulphuric acid can cause no appreciable error in the determination of nitrates, nitrites or the oxides of nitrogen by Lunge's method, unless excessive quantities of sulphuric acid are employed.

The Basic Solutions of Beryllium Sulphate: CHAS. L. PARSONS and W. O. ROBINSON.

Solutions of the normal salts of beryllium have the property to an unusual degree of dissolving large amounts of their own hydroxide or carbonate. The present paper deals with such basic solutions of the sulphate. Freezing-point determinations, on both dilute and concentrated solutions, show that, per mol. of SO_3, any increase in basic ratio over the normal raises the freezing-point. The osmotic effect of the sulphate is, therefore, always decreased by dissolving in it its own hydroxide. The electrical conductivity of the basic solutions is less than that of normal solutions containing the same amount of SO_3. Migration experiments show that beryllium forms no part of the anion. The basic solutions are not precipitated by crystalloids; but on dialysis hydroxide is left on the membrane, and the dialyzed solution has a lower basic ratio.

Further Study of the Sulphates of Beryllium: CHAS. L. PARSONS and CARL T. FULLER.

In the earlier work of one of us, it was found impossible to procure crystals from solutions of the sulphate having a basic ratio greater than BeO/SO_3. Crystals have now been obtained from solutions with a ratio as high as $3BeO/2SO_3$. These crystals are in every case the normal tetrahydrate, and by their separation the mother-liquors are rendered more basic. Repeated attempts to obtain the hexa-hydrate described by Levi-Malvano (*Ztschr. anorg. Chemie,* **48**, 446) have resulted in failure. Although the conditions described by that author were faithfully followed and other methods used, the tetrahydrate invariably separated. A series of experiments on dialyzing the sulphate solutions of a basic nature showed a tendency for the solution to become much less basic by dialysis and the hydroxide was left behind.

The Theory of the Dissociation of Gases around Highly Heated Wires: IRVING LANGMUIR.

In a previous paper the author gave the results of experiments on the dissociation of water vapor and carbon dioxide, made by passing the gases over glowing platinum wires. The present paper shows that under ordinary conditions dissociation phenomena take place so close to the surface of the wire that convection currents do not influence the dissociation. The temperature of the gas near the wire is then calculated from the heat conductivity and the heat given off by the wire. Taking into account the diffusion and the variation of the dissociation constant and of the velocity coefficient with the temperature, a formula is derived which enables one to calculate the difference between the dissociation for equilibrium at the temperature of the wire and the dissociation actually observed after passing the gas over the wire. Applying the formula to the results of the experiments, it is shown that this difference can not exceed 10^{-10} per cent. or only 10^{-5} of the actual dissociation. Therefore the only remaining source of error in the experiments was in the determination of the temperature of the wire and in the analysis of the gases. The results for the dissociation may be considered quite accurate.

The Lime-Silica Series of Minerals: ARTHUR L. DAY and E. S. SHEPHERD.

There are two definite compounds of lime and silica which can exist in contact with the melt: (1) the pseudo-hexagonal metasilicate, melting at 1,512° and inverting to wollastonite at about 1,200°; (2) the orthosilicate of calcium, melting at 2,080° and possessing three polymorphic forms, which have been given the names α, β and γ, in the order of their formation. The α form is monoclinic, density 3.27, hardness 5; the β form is orthorhombic, with about the same density; the γ form has a density of 2.97 and also crystallizes in the monoclinic system. The inversion point α to β occurs at 1,415°; β to γ at 675°. There are three eutectics in the series, tridymite + metasilicate at 35 per cent. CaO, 1,417°; metasilicate + orthosilicate at 54 per cent. CaO, 1,430°; orthosilicate + lime at 67½ per cent. CaO, 2,015°. The constants of the original components are these: pure fused lime has a density of 3.32, hardness 3 +. The fusion temperature is unknown. Lime crystallizes in the isometric system and no polymorphic forms were found. Silica melts very gradually, beginning at about 1,600°, to an ultraviscous liquid. The melting point, like those of albite and orthoclase, is, therefore, indeterminate. At all temperatures above 800° quartz changes to tridymite and quartz glass crystallizes as tridymite, so that above this temperature tridymite is unquestionably the stable phase. The density of pure artificial tridymite is 2.320 (25°); that of quartz glass, 2.213 (25°); the purest natural quartz

has a density of 2.654 (25°). Neither $Ca_2Si_3O_8$, $Ca_4Si_3O_{10}$ nor $3CaOSiO_2$ can exist in the two-component system.

The Effect of Acetone on the Transference Numbers of Sodium and Potassium Chlorides: H. F. Lewis.

It has been found that in general a change of solvent has little or no effect on the transference number of a salt, but no experiments have been published in which acetone was used. In the present investigation the apparatus was a large inverted U tube, the legs of which dipped into large test tubes; by means of a small tube blown into the top or bend of the U tube it was possible to withdraw a sample of the middle portion for analysis. Although the apparatus is not at all adapted to very accurate work, it was shown by blank measurements and tests with indicators that the method was sufficiently good to guarantee that the large differences found are not due to errors. A silver voltameter was used to measure the total decomposition. The cathode portions were analyzed by titrating with deci-normal silver nitrate. The middle portion changed in almost all cases less than one per cent.

	Parts of Acetone.	H	No. of Exp.
NaCl	0	.59	1
	1/8	.55	2
	1/4	.52	2
	1/2	.38	2
	3/4	.38	2
KCl	0	.49	5
	1/8	.44	1
	1/4	.40	3
	1/2	.37	3
	3/4	.31	4

In the above table of results the first column gives the parts of acetone in one of solution; the second column gives the transference number of the chlorine, and the last column gives the number of independent experiments on which the result is based. The experiments were carried out at room temperature; and all the solutions were approximately deci-normal with respect to the salt.

The Electrode Capacity of Iron and its Bearing on Passivity: C. McC. Gordon and Friend E. Clark.

The oldest and most commonly accepted explanation of the passivity of iron carries with it the idea that it is due to a very thin oxide sheet. In later years several other hypotheses have been suggested, which, while perhaps better fitted to explain many of the existing conditions, have not entirely displaced the oxide theory. In case we assume the oxide theory we might expect the so-called passive iron to act as an electric condenser; the conducting iron and the conducting solution being separated by insulating oxide, similar to films on aluminum anodes. Measurements of this capacity—comparing it on the Wheatstone bridge with a metallic condenser of known capacity—have been made for iron electrodes in various solutions, with the following results:

(1) Passive iron (electrodes) acts as if covered with a sheet of oxide, as is evidenced by the following facts: (*a*) The electrodes have a capacity easily measured while active electrodes (that is, iron in dilute nitric acid or freshly deposited electrolytic iron) show no signs of such capacities. (*b*) The capacity values are about of the same order of magnitude as those of aluminum, where we certainly know there is such capacity. (*c*) Electrodes oxidized in a Bunsen burner flame give a similar capacity. The oxidized sheet, so formed, appears to be five or six times as thick as that of the electrodes made passive by the concentrated nitric acid. It is notably different, too, in that it has a small resistance. It acts like a leaky condenser, or a condenser in parallel with a resistance. (2) Iron transferred from the air to neu-

tral solutions behaves qualitatively exactly like iron oxidized in the flame. Its capacity, however, is somewhat larger than that of the passive iron, indicating a thin film or sheet. The resistance of this sheet is relatively smaller, due, as we suppose, to small holes or crevasses in the sheet.

The Electrical Conductivity of Tungstate Solutions: ROGER CLARK WELLS.

A study of the conductivity of various tungstates showed that in the case of sodium metatungstate and ammonium paratungstate a partial transposition begins to take place as soon as those salts are dissolved in water. Although the rate of this transformation is very slow at 25°, it increases rapidly with rising temperature. This discovery will undoubtedly explain the queer solubility determinations which several investigators have found for these salts without considering the time factor.

Freezing-point Measurements: W. G. SMEATON.

The author takes up a consideration of the difficulties encountered in freezing-point determinations and then proposes a method which is a modification of the Raoult method. This modification is based on the fact that, although cryohydrates are theoretically ideal cooling baths, in practise their use necessitates the introduction of the Nernst and Newton constants. The use of these constants is made necessary because the temperature of the cooling bath can not be regulated to produce a temperature equilibrium in the freezing-point vessel at the apparent freezing-point of the solution in all cases. In applying the modification it is most convenient to use a mixture of ice and salt. An auxiliary cooling bath permits rapid determinations. The apparent freezing-point is first determined rapidly in the auxiliary cooling bath. Then the temperature of the cooling bath is regulated to give temperature equilibrium at the apparent freezing-point. In the meantime the ice has been thawed out of the freezing-point vessel which is undercooled in the auxiliary bath and then is transferred to the other bath. Inoculation is made when the temperature begins to rise uniformly. Thus the degree of undercooling is determined with the maximum of accuracy. Ice formation is prevented during undercooling by vigorous hand stirring. The method is rapid, easily manipulated, and gives accurate determinations with very small volumes of solution. The only correction to be applied arises from the change in concentration of the solution through the ice separated. The factor to be applied is a constant for a given apparatus under uniform conditions.

On Amorphous Sulphur; IV. Precipitated Sulphur: ALEXANDER SMITH and R. H. BROWNLEE.

This investigation deals with the proportions of amorphous sulphur ('supercooled $S\mu$') contained in sulphur which has been precipitated (1) from sodium polysulphide by the action of acids and of iodine, and (2) from sodium thiosulphate by the action of equivalent and excessive amounts of acids. The sulphur from polysulphides —so-called 'amorphous sulphur'—is almost wholly crystalline soluble sulphur. When the thiosulphate is used, different acids in equivalent concentrations give different proportions of amorphous sulphur. For a single acid the proportion increases more rapidly than the concentration of the acid. The proportion of insoluble sulphur seems to be greater the more rapid the action (due to high concentration of the acid), and therefore the smaller the droplets and the quicker the hardening of the precipitated liquid $S\mu$. Higher temperatures up to 25° hasten the action, and therefore give larger proportions of amorphous sulphur; but at 40° the tendency of $S\mu$ to revert to

$S\lambda$ asserts itself and the proportions are smaller.

On Amorphous Sulphur; V. Further Study of the Two Forms of Liquid Sulphur as Dynamic Isomers: ALEXANDER SMITH and C. M. CARSON.

This investigation deals with (1) measurements of the rate of transformation $S\lambda = S\mu$ in presence of different catalyzers; (2) study of the influence of iodine, a second component; (3) investigation of freezing-point phenomena of $S\lambda$ and determination of the 'natural' freezing-point (114.5°); (4) thermal effects when liquid sulphur is heated rapidly; (5) measurements of concentrations of $S\mu$ when equilibrium has been reached at temperatures between 155° and 165°; (6) measurements of concentrations of $S\mu$ when liquid sulphur is being heated rapidly; (7) relations of viscosity to preceding results; (8) discussion of causes of the thermal effects and of the whole problem in the light of these results.

G. R. WHITE,
Press Secretary.

(To be concluded.)

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES.

THE degree of doctor of philosophy or doctor of science has this year been conferred, as shown in the accompanying table, on 325 students by institutions competent to award these degrees. The number in 1906 is exactly the same as in 1905, but these two years represent an advance over any preceding year, bringing the number of doctorates conferred during the last nine years to 2,387. These figures do not include those who have received the degree or its equivalent from foreign universities. No statistics are at hand in regard to these students, but the number is probably in the neighborhood of fifty annually. We have not the information that would enable us to say what percentage of those who take the doctor's degree continues to engage in research work and productive scholarship, but probably not more than one third. Neither are there any data showing what percentage of those who are engaged in the advancement of science and learning holds the doctor's degree, but it may be estimated at about half. In so far as these estimates are correct, there would be about 250 men a year added to those who will hereafter devote themselves with some success to research work, and of these about half will work in the exact and natural sciences.

It must be confessed that this number is disappointingly small when the population and wealth of the country are considered. Dr. W. T. Harris, in the last report of the

TABLE I.

DOCTORATES CONFERRED.

	1898	1899	1900	1901	1902	1903	1904	1905	1906	Total
Harvard	26	24	36	29	31	28	46	38	46	304
Chicago	36	24	37	36	27	32	36	44	31	303
Yale	34	30	26	39	29	36	39	34	29	296
Columbia	22	33	21	25	32	39	29	38	42	281
Johns Hopkins	33	38	33	30	17	23	31	35	32	272
Pennsylvania	24	20	15	25	14	29	18	26	28	199
Cornell	19	7	19	21	23	20	13	21	19	162
Clark	12	5	9	7	1	4	10	18	13	79
Wisconsin	5	6	5	6	11	4	12	9	9	67
Michigan	7	4	5	3	10	10	8	7	8	62
New York	5	9	7	6	4	4	9	7	9	60
Boston	0	0	0	0	0	4	7	14	10	35
California	1	3	2	2	1	3	3	4	9	28
Virginia	0	2	2	8	6	3	1	1	0	23
George Wash	1	0	5	3	2	4	3	3	2	23
Princeton	0	3	3	3	1	1	2	5	5	23
Minnesota	1	2	3	2	3	3	3	3	2	22
Bryn Mawr	3	3	1	2	2	0	5	2	2	20
Brown	1	3	3	2	2	5	0	2	1	19
Nebraska	2	1	1	1	0	0	2	3	7	17
Catholic	1	0	0	0	2	2	5	1	5	16
Stanford	2	0	2	2	2	1	1	1	2	13
Iowa	0	0	0	0	0	2	0	2	5	9
Washington	0	2	0	1	0	1	1	0	2	7
Georgetown	0	0	0	0	0	3	1	2	0	6
Vanderbilt	0	0	3	1	0	0	0	0	1	5
Colorado	0	1	0	0	0	0	2	0	2	5
North Carolina	0	0	0	0	2	1	0	1	0	4
Illinois	0	0	0	0	0	0	0	1	3	4
Cincinnati	0	0	0	0	0	1	1	1	0	3
Kansas	0	1	0	0	0	2	0	0	0	3
Lafayette	0	0	0	0	0	3	0	0	0	3
Missouri	0	1	0	0	0	0	0	2	0	3
Northwestern	1	1	0	1	0	0	0	0	0	3
Wash. and Lee	0	0	0	0	1	0	1	0	1	3
Lehigh	0	0	0	0	0	2	0	0	0	2
Syracuse	0	1	0	0	1	0	0	0	0	2
Tulane	0	0	1	0	0	0	0	0	0	1
	236	224	239	255	224	270	289	325	325	2387

commissioner of education, states that in 1903 there were 20,887 professors and teachers in the colleges and universities of the United States, not counting professional schools; there were further in the secondary schools 33,795 teachers; or in all considerably more than 50,000 positions. At least one twentieth of these become vacant each year, and the number of new positions is increasing at the rate of more than 2,000 a year. There are probably more than 5,000 academic positions a year which should be filled by the type of men of which the supply appears to be only about 250. Further, these men must fill the large and increasing number of positions in the government service and elsewhere.

There has naturally been no considerable change in the productivity of the different institutions. Chicago and Yale conferred fewer degrees this year than usual, Harvard and Columbia more, and the Johns Hopkins about its average number. These five universities stand very close in their total influence. Harvard is now at the head of the list, surpassing Chicago by one degree, Yale by 8 degrees, Columbia by 23 degrees and the Johns Hopkins by 32 degrees. Several of the state universities have made considerable gains, which are especially noticeable when compared with the earlier years covered by the statistics. Thus this year California conferred 9 degrees; Nebraska, 7; Iowa, 5, and Illinois, 3, or 24 in all, whereas in 1898 these four universities conferred but 3 degrees.

Table II. shows the number of degrees conferred in the sciences enumerated in Table III. From this table it appears that somewhat less than half of all the degrees conferred are in these sciences. The last column of the table gives the percentage of degrees that are conferred in the natural and exact sciences. It thus appears that relatively more graduate work in science is done at Cornell and the Johns Hopkins than at Harvard and Yale.

TABLE II.

DOCTORATES CONFERRED IN THE SCIENCES.

	1898	1899	1900	1901	1902	1903	1904	1905	1906	Total	P. Ct.
Johns Hopkins	19	17	20	19	9	10	17	18	18	147	54
Chicago	12	13	19	16	15	21	14	21	14	145	48
Columbia	10	23	12	13	14	18	11	20	16	137	49
Harvard	11	7	15	15	14	15	23	12	17	129	42
Yale	11	15	10	18	10	13	15	13	15	120	41
Cornell	11	2	11	13	16	13	8	13	7	94	58
Pennsylvania	8	8	6	12	5	14	9	12	11	85	43
Clark	12	5	9	7	1	4	10	18	9	75	95
Michigan	0	3	1	0	5	4	6	?	5	24	39
Wisconsin	2	4	1	3	4	0	4	3	2	23	34
California	1	3	1	2	1	3	2	3	3	19	68
George Wash.	1	0	3	1	1	4	1	3	2	16	69
Brown	1	0	0	1	2	4	0	2	1	11	58
Nebraska	2	1	1	1	0	0	1	2	3	11	65
Bryn Mawr	1	2	1	2	1	0	2	0	1	10	50
Stanford	2	0	0	1	2	1	1	1	2	10	77
Princeton	0	3	1	0	0	1	1	3	0	9	39
Virginia	0	2	0	4	1	2	0	0	0	9	39
Minnesota	0	1	1	0	2	1	0	1	1	7	32
Washington	0	2	0	1	0	1	1	0	2	7	100
Iowa	0	0	0	0	0	1	0	2	3	6	67
New York	1	1	0	1	0	0	1	1	1	6	10
Catholic	0	0	0	0	1	2	1	0	0	4	40
Colorado	0	1	0	0	0	0	0	0	2	3	60
Kansas	0	1	0	0	0	2	0	0	0	3	100
North Carolina	0	0	0	0	2	1	0	0	0	3	75
Vanderbilt	0	0	1	1	0	0	0	0	1	3	60
Wash. and Lee	0	0	0	0	1	0	1	0	1	3	100
Illinois	0	0	0	0	0	0	0	0	2	2	50
Lehigh	0	0	0	0	0	2	0	0	0	2	100
Missouri	0	1	0	0	0	0	0	1	0	2	67
Northwestern	0	1	0	1	0	0	0	0	0	2	67
Cincinnati	0	0	0	0	0	0	0	1	0	1	33
Georgetown	0	0	0	0	0	0	1	0	0	1	17
Lafayette	0	0	0	0	0	1	0	0	0	1	33
Syracuse	0	0	0	0	1	0	0	0	0	1	50
	105	116	113	132	108	138	130	150	139	1131	47

The third table gives the degrees conferred in each of the sciences, whence it appears that last year 38 degrees were given in chemistry, 21 in zoology, 19 in physics, 16 in botany, 12 in psychology, 11 in geology and 9 in mathematics. All the other sciences are responsible for only 13 degrees.

The institutions that conferred three degrees or more in special subjects are as follows: *Johns Hopkins,* chemistry 9, physics 4; *Chicago,* chemistry 4; *Columbia,* botany 4, chemistry 3; *Harvard,* zoology 7, chemistry 3; *Yale,* chemistry 7; *Cornell,* zoology 3; *Pennsylvania,* chemistry 4; *Clark,* psychology 6.

TABLE III.

DOCTORATES CONFERRED IN THE SCIENCES.

	1898	1899	1900	1901	1902	1903	1904	1905	1906	Total
Chemistry	27	32	26	28	27	33	35	36	38	282
Physics	11	7	15	24	12	14	17	14	19	133
Zoology	12	11	11	15	16	12	15	15	21	128
Psychology	18	15	9	13	8	18	10	21	12	124
Botany	11	11	12	8	12	9	17	15	16	111
Mathematics	11	13	11	18	8	7	13	20	9	110
Geology	6	5	5	10	6	10	7	4	11	64
Physiology	4	1	4	1	8	8	1	3	3	33
Astronomy	3	2	4	5	2	4	4	3	4	31
Education	0	5	8	2	1	2	0	6	0	24
Sociology	0	5	3	3	4	2	1	1	0	19
Paleontology	0	4	2	1	0	2	2	3	2	16
Bacteriology	0	1	1	1	1	3	3	0	1	11
Anthropology	2	0	2	1	0	1	2	1	0	9
Agriculture	0	0	0	0	2	2	2	2	0	8
Engineering	0	0	0	1	0	3	1	3	0	8
Mineralogy	0	2	0	0	1	1	0	1	1	6
Anatomy	0	1	0	1	0	4	0	0	0	6
Pathology	0	0	0	0	0	3	0	0	1	4
Metallurgy	0	0	0	0	0	0	0	1	1	2
Geography	0	0	0	0	0	0	0	1	0	1
Meteorology	0	1	0	0	0	0	0	0	0	1
	105	116	113	132	108	138	130	150	139	1131

The names of those on whom the degree was conferred in the natural and exact sciences, with the subjects of their theses, are as follows:

JOHNS HOPKINS UNIVERSITY.

Samuel James Allen: 'The Velocity and Ratio e/m for the Primary and Secondary β Rays of Radium.'

Roger Frederic Brunel: 'A Study of the Salts of Tautomeric Compounds. Reactions of Urazole Salts with Alkyl Halides.'

Robert Ervin Coker: 'Diversity in the Scutes and Bony Plates of *Chelonia*.'

Thomas Sidney Elston: 'The Fluorescent and Absorption Spectra of Anthracene and Phenanthrene Vapors.'

Howard Edwin Enders: 'A Study of the Life History and Habits of *Chætopterus Variopedatus*.'

Charles Walter Gray: 'An Electrical Method for the Simultaneous Determination of Hydrogen, Carbon and Sulphur in Organic Compounds.'

Charles Clayton Grove: I., 'The Syzygetic Pencil of Cubics and a New Geometrical Development of its Hesse Group G_{216}.' II., 'On the Complete Pappus Hexagon.'

Ernest Jenkins Hoffman: I., 'Osmotic Pressure of Cane-sugar Solutions.' II., 'The Semi-permeable Membrane of Copper Cobalticyanide.'

B. Smith Hopkins: 'The Osmotic Pressure of Glucose Solutions, and the Freezing-point Depressions and Densities of Solutions of Glucose and Cane Sugar; also Some Experiments on the Osmotic Pressure of Urea Solutions.'

Edward Pechin Hyde: 'Talbot's Law as applied to the Rotating Sectored Disk.'

William Lee Kennon: I., 'Osmotic Pressure of Solutions of Cane Sugar.' II. 'A Study of Zinc Ferrocyanide as a Semi-permeable Membrane for the Measurement of Osmotic Pressure.'

LeRoy McMaster: 'The Conductivity and Viscosity of Solutions of Certain Salts in Water, Methyl Alcohol, Ethyl Alcohol, Acetone and Binary Mixtures of these Solvents.'

John Frederick Messick: 'Cubic Curves in Reciprocal Triangular Situation.'

August Herman Pfund: 'Polarization and Selective Reflection in the Infra-red Spectrum.'

William Frederick Prouty: 'The Niagara and Clinton Formations of Maryland.'

Charles Judson Robinson: I., 'A Continuation of the Study of the Action of Amines on Camphoroxalic Acid.' II., 'The Combustion of Halogen Compounds in the Presence of Copper Oxide.' III., 'Some Experiments relating to the so-called Infusible Diamide of Parasulphaminebenzoic Acid.'

Charles August Rouiller: 'The Relative Migration Velocities of the Ions of Silver Nitrate in Water, Methyl Alcohol, Ethyl Alcohol and Acetone, and in Binary Mixtures of these Solvents, together with the Conductivity of such Solutions.'

William Anderson Syme: 'Some Constituents of the Poison Ivy Plant (*Rhus Toxicodendron*).'

HARVARD UNIVERSITY.

Henry Bryant Bigelow: 'Studies on the Nuclear Cycle of *Gonionemus murbachii* Mayer.'

Leon Jacob Cole: 'An Experimental Study of the Image-forming Powers of Various Types of Eyes.'

Harvey Nathaniel Davis: I., 'A *PQ* Plane for Thermodynamic Cyclic Analysis.' II., 'The Longitudinal Vibrations of a Rubbed String.'

James Walter Goldthwait: 'The Abandoned Shore Lines of Eastern Wisconsin.'

Murray Arnold Hines: 'A Revision of the Atomic Weight of Manganese.'

Arthur Day Howard: 'The Visual Cells in Vertebrates, chiefly in *Necturus Maculosus*.'

Burritt Samuel Lacy: 'Temperature Coefficients of Concentration Cells and of Electrodes, and the Thomson Effect in Electrolytes.'

George Richard Lyman: 'Culture Studies of Hymenomycetes.'

John Hancock McClellan: 'The Development of the Excretory System of *Amia calva*.'

Hansford MacCurdy: 'The Influence of Selection on Color Pattern in Guinea Pigs and Rats.'

Robert Dawson MacLaurin: 'Derivatives of Substituted Orthobenzoquinones.'

George Rogers Mansfield: 'The Origin and Structure of the Roxbury Conglomerate.'

Samuel Ottmar Mast: 'Light Reactions in Lower Organisms: I. *Stentor Cœruleus*.'

Lincoln Ware Riddle: 'Contributions to the Cytology of the Entomophthoraceæ.'

William Henry Roever: 'Brilliant Points.'

Alpheus Wilson Smith: 'Expansion and Compressibility of Ether and of Alcohol in the Neighborhoods of their Boiling Points.'

Herbert Eugene Walter: 'The Reactions of Planarians to Light.'

COLUMBIA UNIVERSITY.

Howard J. Banker: 'A Contribution to a Revision of the North American Hydnaceæ.'

Frederic Columbus Blake: 'The Reflection and Refraction of Electrical Waves by Screens of Resonators and by Grids.'

Ira Detrich Cardiff: 'A Study of Synapsis and Reduction.'

Frederick Van Dyke Cruser: 'The Insoluble Chromicyanides.'

Henry Allan Gleason: 'A Revision of the North American Vernonieæ.'

Louis Hussakof: 'Studies on the Anthrodira.'

Clarence Whitney Kanolt: 'The Combination of a Solvent with the Ions.'

Raymond Carroll Osburn: 'The Origin of Vertebrate Limbs. Recent Evidence upon this Problem from Studies on Primitive Sharks.'

Fred James Pack: 'The Geology of Pioche, Nev., and Vicinity.'

Thomas Thornton Read: 'The Amalgamation of Gold Ores.'

Charles Budd Robinson: 'The Characeæ of North America.'

Harvey Ambrose Seil: 'Further Investigations in the Quinazoline Group.'

John Fairfield Thompson: 'Platinum Silver Alloys.'

Frederic Lyman Wells: 'Linguistic Lapses, with especial reference to the Perception of Linguistic Sounds.'

Samuel Robinson Williams: 'On the Reflection of Cathode Rays from Thin Metallic Films.'

John Howard Wilson: 'Glacial History of Nantucket and Cape Cod, with an Argument for a Fourth Center of Glacial Dispersion in North America.'

YALE UNIVERSITY.

Raymond Harman Ashley: 'The Oxidation of Sulphur Dioxide in Analysis.'

Kate Grace Barber: 'Comparative Histology of Fruits and Seeds of Certain Species of Cucurbitaceæ.'

Edward Herbert Cameron: 'Voluntary Production of Tones under Varying Conditions of Attention.'

Haroutune Mugurdich Dadourian: 'On the Radioactivity of Underground Air and on Some Radioactive Properties of Thorium.'

Robert Banks Gibson: 'On Proteose Fever: an Experimental Study.'

Albert Hileman: 'The Determination of Fluorine eliminated as Silicon Fluoride.'

Carl Oscar Johns: 'Researches in Organic Chemistry.'

Ellis Earle Lawton: 'Wave-lengths and Structural Relation of Certain Bands in the Spectrum of Nitrogen.'

Gerald Francis Loughlin: 'Contribution to the Geology of Eastern Connecticut.'

Elmer Verner McCollum: 'Researches in Organic Chemistry.'

George Albert Menge: 'Researches in Organic and Physical Chemistry.'

Seth Enoch Moody: 'The Hydrolysis of Certain Dissolved Salts in Presence of Iodides and Iodates.'

Roland George Dwight Richardson: 'Improper Multiple Integrals.'

Clifton James Sarle: 'The Medina Formation and Fauna of New York.'

Gustaf Eric Wahlin: 'The Relation between the Binary Quadratic Forms and the Quadratic Numerical Bodies.'

UNIVERSITY OF CHICAGO.

James Francis Abbott: 'The Morphology of Cœloplana.'

Russell Burton-Opitz: 'The Periodic and Irregular Variations in the Venous Blood-flow.'

Harvey Carr: 'Some Visual Illusions due to Eye Closure.'

David John Davis: 'The Bacteriology of Whooping Cough.'

William Lloyd Evans: 'The Action of Alkalies and Oxidizing Agents on Benzoyl Carbinol.'

Henry Max Goettsch: 'The Affinity Constants of Diacid Bases.'

Frank Loxley Griffin: 'Certain Periodic Orbits

of *K* Finite Bodies revolving about a Relatively Large Central Mass.'

Glenn Moody Hobbs: 'The Relation between *P.D.* and Sparking Distance for Small Values of the Latter.'

William Raymond Longley: 'A Class of Periodic Orbits of an Infinitesimal Body subject to the Attraction of *N* Finite Bodies.'

Carleton John Lynde: 'The Effect of Pressure on Surface Tension.'

William McCracken: 'On the Hydrochlorides of Imido-ether Derivatives.'

Stephen Walter Ranson: 'Retrograde Degeneration in the Spinal Nerves.'

Hermann Irving Schlesinger: 'Velocity Determinations with Imido-ethers.'

Delonza Tate Wilson: 'Work on Minor Planets.'

UNIVERSITY OF PENNSYLVANIA.

Samuel Goodwin Barton: 'Secular Perturbations arising from the Action of Saturn on Mars, an Application of the Method of Louis Arndt.'

Benjamin Franklin Finkel: 'Determination of all Groups of Order 2 which contain Cyclic Self-conjugate Sub-groups of Order 2 and whose Generating Operations correspond to the Partitions.'

Anna Lockhart Flanigen: 'The Electrolytic Determination of Copper in an Alkaline Cyanide Electrolyte.'

Benno Humbert Alfred Groth: 'The Sweet Potato, Origin and History, Economic Value, Structure and Classification of Varieties.'

Joel Henry Hildebrand: 'The Determination of Anions in the Electrolytic Way.'

Edith Dabele Kast: 'The Mean Right Ascensions and Proper Motions of 130 Stars.'

Louis Krautter, Jr.: 'The Genus Pentstemon.'

Julia Langness: 'A New Form of Anode in Electro-analysis and the Rapid Electrolytic Determination of Certain Platinum Metals.'

Jesse Francis McClendon: 'On the Development of Parasitic Copepoda.'

Charles Travis: 'Pyrite from Cornwall, Lebanon County, Pennsylvania.'

Luther Ferree Zerr Witmer: 'The Electrolytic Determination of Tin and its Separation from Antimony with a Rotating Anode.'

CLARK UNIVERSITY.

Frank Kelton Bailey: 'On the Latent Heat of Recalescence in Iron and Steel.'

William Frederick Book: 'The Acquisition of Skill in Typewriting.'

Alvin Borgquist: 'Crying.'

Alfred A. Cleveland: 'The Psychology of Chess and of Learning to Play it.'

Frederick N. Duncan: 'A Comparative Study of Contractile Tissue.'

Arnold Lucius Gesell: 'Jealousy.'

George Edmund Myers: 'A Comparative Study of Moral Training.'

James P. Porter: 'The Habits, Instincts and Mental Powers of Spiders, Genera *Argiope* and *Epeira*.'

James Theron Rood: 'Quantitative Investigations on the Transmission of Sound by the Telephone.'

CORNELL UNIVERSITY.

Cornelius Betten: 'The Wing Venation of Trichoptera.'

Elmer Clifford Colpitts: 'On the Twisted Quintic Curves.'

Samuel Perkins Hayes: 'A Study of the Affective Qualities.'

Thomas J. Headlee: 'Phylogeny of the Butterflies as shown by their Wing Venation.'

Martin Joshua Iorns: 'Influence of Acetylene Light on Plant Growth.'

Helen Isham: 'A Contribution to the Chemistry of Hydronitric Acid.'

Charles Herschel Sisam: 'Ruled Surfaces of Order Seven having a Rectilinear Directrix.'

UNIVERSITY OF MICHIGAN.

Alfred Dachnowski: 'Beitrag zur Kenntnis der Entwicklungs-Physiologie von Marchantia polymorpha, L.'

William D. Henderson: 'The Thermo-electric Behavior of Silver in a Thermo-element of the First Class.'

Rufus Percival Hibbard: 'Influence of Tension on the Formation of Mechanical Tissue in Plants.'

Alexander Grant Ruthven: 'Genetic Relationships among the Garter Snakes.'

John Frederick Shepard: 'Organic Changes and Feeling.'

UNIVERSITY OF CALIFORNIA.

Sebastian Albrecht: I., 'A Spectrographic Study of the Fourth Class Variable Stars Y Ophiuchi and T. Vulpeculæ.' II., 'On the Distortions of Photographic Films on Glass.'

Nathaniel Lyon Gardner: 'Cytological Studies in Cyanophyceæ.'

Charles David Snyder: 'The Influence of Temperature upon the Heart Rhythm in the Light of the Law of Chemical Reaction Velocity as influenced by Temperature.'

STATE UNIVERSITY OF IOWA.

Rudolph Martin Anderson: 'The Birds of Iowa.'

Charles Howard Edmonson: 'The Protozoa of Iowa.'

Daniel Starch: 'Perimetry of the Location of Sound.'

UNIVERSITY OF NEBRASKA.

Charles Newton Gould: 'The Geology and Water Resources of Oklahoma.'

Jesse Perry Rowe: 'Montana Coal and Lignite Deposits.'

Robert Thompson Young: 'Development of *Cysticercus*.'

UNIVERSITY OF COLORADO.

Heman Burr Leonard: 'On the Factoring of Composite Algebras.'

James Underhill: 'Areal Geology of Lower Clear Creek.'

GEORGE WASHINGTON UNIVERSITY.

Cornelius Lott Shear: 'Cranberry Diseases.'

Martin Norris Straughn: 'The Chemistry of Different Varieties and Individual Ears of Sweet Corn as affected by Enzymes, Climatic Conditions and Breeding.'

UNIVERSITY OF ILLINOIS.

Melville Amasa Scovell: 'The Salicylic Modification for determining Nitrogen by the Kjeldahl Method.'

Perry Fox Trowbridge: 'Proteids of Flesh.'

LELAND STANFORD JUNIOR UNIVERSITY.

John Merton Aldrich: 'A Catalogue of North American Diptera.'

Walter Kenrick Fisher: Part I., 'Anatomy of *Lattia gigantea* Gray.' Part II., 'Starfishes of the Hawaiian Islands.' Part III., 'Holothurians of the Hawaiian Islands.' Part IV., 'Starfishes of California.' Part V., 'Starfishes collected by the Steamer *Albatross* in Alaska, in 1903.'

WASHINGTON UNIVERSITY.

George Grant Hedgcock: 'Studies upon Some Chromogene Fungi which discolor Wood.'

Perley Spaulding: 'Studies on the Lignin and Cellulose of Wood.'

UNIVERSITY OF WISCONSIN.

Irving Walter Brandel: 'Plant Pigments.'

John Langley Sammis: 'On the Relation between Electrolytic Conductivity and Chemical Activity.'

BROWN UNIVERSITY.

Vahan Simon Babasinian: 'A Study of the Methods of Preparation and the Properties of α-Phenyl-Naphthalene-Dinitro-Dicarboxylic Anhydride.'

BRYN MAWR COLLEGE.

Frances Lowater: 'The Spectra of Sulphur Dioxide.'

UNIVERSITY OF MINNESOTA.

John Zeleny: 'The Velocity of the Ions produced by Röntgen Rays.'

NEW YORK UNIVERSITY.

Maximilian Philip: 'Form and Movements of Liquid Jets.'

VANDERBILT UNIVERSITY.

Griffith Thompson Pugh: 'The Pleistocene of South Carolina.'

WASHINGTON AND LEE UNIVERSITY.

A. F. White: 'Composition of the Waters of Rockbridge County, Virginia, and their relation to the Geological Formations.'

SCIENTIFIC BOOKS.

Gesammelte Werke. By ADOLF VON BAEYER. Vol. I., pp. 1–990, with an introduction, pp. i–cxxxii; Vol. II., pp. 1–1194. Braunschweig, Vieweg and Sohn. 1905.

The friends and students of Adolf von Baeyer deemed his seventieth birthday a fitting occasion for honoring him by the publication of his scientific papers, 278 in number, from 1857 to 1905; and Baeyer graciously gave his consent to the plan. In the introduction, pp. i–xx and xxviii–xxxi, the great chemist gives a brief and very interesting account of the chief events in his life; he then discusses, on pp. xxxi–xxxvii, the main trend and bearing of his scientific work.

Emil Fischer gives, on pp. xxi–xxvii, a striking sketch of the life in the laboratory of Baeyer at Strassburg.

"Es wurde nicht schulmässig unterrichtet sondern kameradschaftlich gearbeitet."

There is also a list, pp. lvi–cxviii, of all the scientific papers published from Baeyer's laboratories, Berlin, 1860–72; Strassburg, 1872–5, and Munich, 1875–1905.

It is hardly possible for any one who has

not had the privilege of being a student in his laboratory to realize the tremendous enthusiasm, energy and resourcefulness with which Baeyer has devoted himself to chemistry during the past forty-eight years. One of his great ambitions was to found a school of chemists; that he has succeeded remarkably in this respect is shown by the fact that for years he has held a position in the chemical world similar to that formerly possessed by Berzelius and by Liebig. In the official address of the German Chemical Society, presented in connection with the seventieth birthday festivities, it is admitted that no one since Berzelius and Liebig has exerted such an influence on chemical teaching and research as Baeyer—and yet Baeyer has written no textbook on chemistry, has made no claims as a pedagogue, and has not added to the science a new law or generalization.

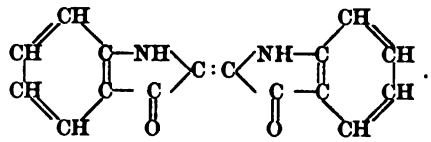
The fact that theories have had so slight an influence on his work—possibly because he realized to the fullest extent their inadequacy and temporary character, but especially because he did not need them in order to make scientific discoveries—deserves special emphasis. He possesses to a remarkable degree the rarest of scientific gifts, namely, the power to ascertain facts accurately regardless of theories—a power which is only to be found in those possessing experimental skill of the highest order. In this respect he is the direct antipode of Kekulé, who was especially interested in developing new views and was not interested in substances as such, and who at times gave one the impression of wishing to adjust nature in harmony with his own theories. In the words of Baeyer, his first student, 'Kekulé war der geborne chemische General, er wollte die Natur commandieren.'

Baeyer, on the other hand, having no special views to present or to defend, approached nature from a totally different standpoint; 'meine Versuche habe ich nicht angestellt um zu sehen ob ich recht hatte sondern um zu sehen wie die Körper sich verhalten.' In other words, he let nature or the facts teach him and then adjusted himself accordingly. One who knows Baeyer, either through personal contact or by means of a thorough and laborious study of his scientific publications, finds in him a love and respect for truth for its own sake which is both rare and admirable. This characteristic, taken in connection with the unusual experimental power shown in his work, explains the marked influence he has exerted on the development of the chemistry of carbon compounds. It is impossible to give here more than a brief statement of the direction of Baeyer's work which deals entirely with the chemistry of carbon.

Regardless of what the future may have in store for us concerning the disintegration of matter, it is certain that the chemistry of the element carbon must always remain of paramount interest because its development is absolutely essential to a fundamental knowledge of the chemical processes going on in the vegetable and animal kingdom and must lead ultimately to a scientifically exact biology and medicine.

Baeyer himself makes nineteen subdivisions in his work from 1857 to 1905; in many cases he was engaged for over a decade on a single subdivision and in most cases he was a pioneer in the field.

His work on indigo, from 1866–70 and from 1877–84, is of general interest because we have here one of the first instances in which a complex plant product was made by synthesis in the laboratory. The synthesis was preceded by years of labor which finally resulted in determining that the 'architecture' of the indigo molecule could be represented by the graphical formula



As the direct outcome of this work, indigo has been manufactured commercially since 1891 from anthranilic acid. Similarly another complex dyestuff, alizarine, has been made commercially since 1875 from coal-tar products, instead of from the madder root, owing to the work of Graebe and Liebermann in Baeyer's laboratory in 1868.

The 'architectural' method is in fact the only method by which we can reasonably hope to make progress in the synthesis of the various complex products found in nature; experience has shown that when the architecture of a definite chemical compound, no matter how complex, has once been thoroughly worked out, it is then often a comparatively simple matter to accomplish its synthesis—whereas the preliminary work may require decades of time.

The plant, which is the great synthetic agent in nature, manufactures at ordinary temperatures under comparatively simple conditions from the carbon dioxide of the air and from the material found in the soil—water, phosphates, nitrates, potassium and ammonium salts, etc.—a vast variety of complex carbon compounds which subsequently undergo various chemical changes in the animal world. There is abundant justification for the conclusion that when the conditions under which these various chemical processes take place are better understood we may reasonably hope to accomplish all these transformations in the laboratory. Much of the faithful and laborious work carried on by investigators in the field of carbon chemistry during the past seventy or more years must in fact be considered preliminary to the accomplishment of this great end.

Baeyer has always shown an unusually great interest in this direction; his indigo work, all his condensation work with aldehydes, alcohols, phthalic anhydride and various benzene derivatives, as well as his synthetic work in the pyrrol, indol, pyridine and quinoline series—all were undertaken with this end in view. He has emphasized the important rôle which formaldehyde must play in the conversion of the carbon dioxide of the air by plants into sugar and starch and has also in this connection discussed theoretically, in 1870, the chemistry of fermentation.

His very important work on the constitution of benzene from 1866–73 and from 1885–94, although fruitless in the main point at issue, led to a thorough and systematical development of the chemistry of di-, tetra- and hexahydro-benzene compounds; this work naturally led him into the field of terpentine chemistry, on which he has spent eight years, from 1893–1901, working out the 'architecture' of many of these important vegetable products as well as synthesizing some of the simplest representatives of the series.

His most recent work has dealt with peroxides, with dibenzalacetone and triphenylmethane and with the basic properties of oxygen. The fact that all carbon compounds containing oxygen, except the peroxides, are capable of forming oxonium salts, containing quadrivalent oxygen, was established by Baeyer on the basis of Collie and Tickle's work on dimethylpyrone; this discovery has excited very general interest.

J. U. NEF.

SOCIETIES AND ACADEMIES.

THE IOWA ACADEMY OF SCIENCE.

THE twentieth annual meeting of the Iowa Academy of Science was held on April 20–21, 1906, in the botanical rooms of the Iowa State College, Ames, Ia. The magnificent new Central Hall was placed at the disposal of the academy. The meetings were all held in the botanical rooms with the exception of the Friday afternoon meeting, which was held in the physics lecture room of Engineering Hall.

Friday afternoon Dr. Hermann von Schrenk, of the U. S. Department of Agriculture, gave an address on the work of the 'Division of Pathology.' On Friday evening Professor Charles R. Barnes, of the University of Chicago, gave an illustrated lecture on 'How Plants breathe.' On Saturday forenoon Professor Charles E. Bessey, of the University of Nebraska, formerly of Iowa State College, gave an address on 'The Forest Trees of Eastern Nebraska.' The meeting of 1906 was probably the most enjoyable in the history of the academy.

The officers for the coming year are:

President—Professor C. O. Bates, of Coe College, Cedar Rapids.

First Vice-president—Professor G. E. Finch, Marion.

Second Vice-president—Professor A. A. Bennett, Iowa State College, Ames.

Treasurer—Professor H. E. Summers, of Iowa State College, Ames.

Secretary—Professor L. S. Ross, of Drake University, Des Moines.

The meeting in 1907 will be held at Drake University.

The following program was presented:

M. F. Arey: 'A Review of the Development of Mineralogy.'

H. W. Norris: 'The Carotid Arteries and their Relation to the Circle of Willis in the Cat.'

N. Knight: 'A Study of Dolomite and Magnesite with special reference to the Separation of Calcium and Magnesium.'

Bruce Fink: 'Ecological Notes from an Illinois Esker.'

J. Fred Clark: 'The Disparity between Age and Development in the Human Family.' (Illustrated by pronounced cases due to thyroid malformations.)

L. H. Pammel: 'Some Diseases of Rocky Mountain Plants.'

John L. Tilton: 'An Attempt to illustrate Tides and Tidal Action.'

J. E. Todd: (*a*) 'More Light on the Origin of the Missouri River Loess,' (*b*) 'Some Variant Conclusions in Iowa Geology.'

W. S. Hendrixson: (*a*) 'The Action of Bromic Acid on Metals,' (*b*) 'Logarithmic Factors for Use in Water Analysis,' (*c*) 'A List of Chemical Periodicals in Iowa.'

T. J. Fitzpatrick: 'The Liliaceæ of Iowa.'

L. Begeman: 'Mutual Induction and Internal Resistance of a Battery.'

Bruce Fink: 'Lichens and Recent Conceptions of Species.'

T. E. Savage: 'Some Unusual Features of the Maquoketa Shale in Jackson County, Iowa.'

A. T. Erwin: '*Amelanchier alnifolia* and its Cultivated Forms.'

Paul Bartsch: 'The Iowa Ornithological Literature of the Nineteenth Century.'

Walter J. Meek: 'A Study of the Choroid Plexus.'

Frank F. Almy: (*a*) 'The Effect of Pressure on Lines in the Spectrum of Iron,' (*b*) 'A Simple Demonstration of the Doppler Effect in Sound,' (*c*) 'The Physical Laboratory of Iowa College.'

G. E. Finch: 'A Portion of the Iowan Drift Border in Fayette County, Iowa.'

B. A. Place: 'The Relation of the Motor Nerve Endings to Voluntary Muscle in Amphibia.'

Fred J. Seaver: 'Notes on the Discomycete Flora of Iowa.'

Charles R. Keyes: (*a*) 'Lime Creek Fauna of Iowa in Southwestern United States and Northern Mexican Region.' (*b*) 'Geology of the Corinth Canal Zone.' (*c*) 'Alternation of Fossil Faunas.'

J. E. Guthrie: 'The Collembolan Eye.'

J. M. Lindly: 'Flowering Plants of Calcasieu Parish, Louisiana.'

F. A. Brown: 'Some Contributions to Madison County Geology.'

O. M. Oleson and M. P. Somes: 'Flora of Webster County, Iowa.'

K. E. Guthe: 'Electrical Units.'

H. P. Baker: 'The Holding and Reclamation of Sand Dunes by Tree Planting.'

L. S. Ross: (*a*) 'The Food of Subterranean Crustacea,' (*b*) 'Number of Bacteria in Des Moines School Buildings.'

B. O. Gammon: 'Cladocera in the Vicinity of Des Moines.' Presented by L. S. Ross.

D. W. Morehouse: 'Photographic Accessories of Drake University Equatorial.' Introduced by L. S. Ross.

C. O. Bates: 'Municipal Hygiene—Part II., Milk.'

B. Shimek: (*a*) 'Notes on Certain Iowa Trees and Shrubs,' (*b*) 'The Loess of the Missouri Bluffs.'

J. A. Udden: 'Cyclonic Distribution of Precipitation.'

L. S. Ross,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE MUTATION THEORY AGAIN.

Certain objections to the mutation theory of de Vries have called forth the wrath of Professor C. S. Gager, and he emphatically demands that this theory should be thoroughly understood before we discuss it.[1] With more zeal than discretion he affirms that this lack of understanding is shown in two recent articles published in Science, one of which has the present writer for its author;[2] he calls these articles a display of mental density, claiming that the views of de Vries have been misrepresented; but with reference to my own paper he only succeeds in demonstrating that he in turn has entirely failed to grasp the

[1] De Vries and his critics, in Science, July 20, 1906, p. 81 ff.

[2] Science, May 11, 1906, p. 746 ff.

essence of my views, and further, that other publications of mine on this and kindred subjects, which are absolutely necessary for the proper understanding of my views, are unknown to him.

The chief purpose of my article was to object to de Vries's conception of mutation and elementary species. If I object to these terms, of course, I do not accept them, and since I have given reasons for believing that they are wrong, the only appropriate rejoinder to this would be to show that my reasons are no good. Instead of this, Gager is satisfied with the vague and superficial statement that it is impossible to satisfactorily define the concept of species, neglecting entirely what I have written on this topic previously,[3] and, further, he spills a good deal of ink in reiterating de Vries's contentions.

Gager says:[4] "*When a careful worker says that he obtained a given form that breeds absolutely true, and which, for reasons fully explained, he calls an 'elementary species,' by means of a certain definite and clearly explained kind of variation which he defines and names 'mutation,' let us not refer to him as 'claiming to' have done so, or to the mutant as 'seeming to' breed true.*"

Here we have a concise statement of de Vries's claim, namely, that *he obtained a form that breeds true by means of mutation.* I have said[5] that de Vries claims '*that mutants are species.*' But if de Vries calls a form that breeds true an elementary species, *he obtained species by means of mutation;* and if the product of the process of mutation is a mutant, of course, *a mutant is obtained by means of mutation,* and, consequently, *mutants are* (*elementary*) *species.* Thus it is evident that my expression of de Vries's claim is *absolutely correct* and identical in its meaning with that given by Gager, *and his allegation that I have misunderstood de Vries is entirely unwarranted.* It rather seems that Gager himself has not fully understood what de Vries says, at any rate, that he was not aware of the true meaning and import of de Vries's theory. This is due, in part, to the fact that de Vries himself was not conscious of the logical consequences of his views, he belonging to the class of writers who are oblivious of the most fundamental principles of evolution.[6]

However, as I have endeavored to show, *I do not accept* the view that *mutants are species,* or *that de Vries obtained a form that breeds true by means of mutation.* In opposition to this I say, *that he obtained such a form by means of selection and segregation out of a certain kind of variation* (*mutation*). Indeed, Gager endorses also the latter view[7] by an emphatical 'Exactly!' and asks: 'why the dissenting critique?'

This plainly shows that, for Gager, these two phrases are identical, namely, that de Vries *obtained species by means of mutations,* and that he *obtained them by means of selection and segregation out of mutations.* Possibly my mental density comes in here; but I can not help it; I must regard these two phrases as having a *different* meaning, and this is the reason for my 'dissenting critique'; de Vries *never* said anything that might be interpreted in the sense of the second sentence.

That de Vries's view is wrong I have demonstrated by pointing out that the mutants actually did not breed true before he started his experiments, and very likely they would not have bred true if he had not taken them under his care. They began to breed true, not because they were mutants, formed by the process of mutation, but because he introduced two factors, which were absent previously, namely, selection and segregation. 'Pedigree-culture is the method required,' as Gager[8] quite correctly insists, but apparently without knowing of what it consists. The essential factors in pedigree-culture are selection and segregation, and pure strains are only ob-

[3] *Pr. Amer. Philos. Soc.*, 35, 1896.

[4] *L. c.*, p. 89.

[5] *L. c.*, p. 746.

[6] See Ortmann, SCIENCE, June 22, 1906, p. 947 ff.

[7] *L. c.*, p. 87, in the form: '*If de Vries had claimed that species might be made out of mutations*' (Ortmann, p. 747), namely, as is said in the same paragraph, but carefully omitted by Gager, *by means of selection and segregation.*

[8] *L. c.*, p. 86.

tained after a number of generations, as is seen in de Vries's experiments.

This is so evident, that it is simply astonishing that Gager is not capable of seeing it, even after attention has been called to it, and that he does not see that this is an important part of my objections, namely, *that it is selection and segregation that make mutants breed true.* Indeed, he asks:[9] "Where, from cover to cover, of 'Species and Varieties,' is any other claim made?" Please look at the title: 'Species and Varieties, their Origin by Mutation'; is this identical with 'Species and Varieties, their Origin by Selection and Segregation'? In my opinion, the *first* phrase means that by the process of mutation species (elementary species, which breed true) are made; the *second,* that selection and separation make them breed true. The *first* means that the quality of breeding true was created by the mutation process, before de Vries made the experiments, and (as de Vries says in the text) that the latter were undertaken only in order to *test,* to ascertain the existence of this quality; while the *second* means that the quality of true breeding was created, not by the process of mutation, but by the subsequent processes of selection and segregation. If Gager can not see the difference, I am sorry for him; or should it again be a case of mental density on my part?

If we remove this fundamental fallacy out of de Vries's theory, that it is not the process of mutation, but that of selection and segregation, which makes species breed true, nothing remains but the view that mutation is a peculiar kind of variation, which alone may start the species-making process, or which alone is apt to finally produce true breeding forms. A part of my article is written with reference to this possible claim, although I know very well that de Vries did not make it separately,[10] but always in connection with the first claim, that it is the process of mutation which produces true-breeding, elementary species.

[9] *L. c.*, p. 87.

[10] That I did not intend to represent this as de Vries's view, but only as a possible modification of it, is clearly seen in SCIENCE, June 22, 1906, p. 950, foot-note 9.

Gager[11] quotes my sentence,[12] but omits the introductory and important words: 'aside from the above claim.' This, of course, affords him a chance to show that I have misunderstood de Vries. But if we exclude the only test for the elementary species, that they should be true-breeding forms, as unsatisfactory, no other difference remains between fluctuating variation and mutation, but the degree or amount of deviation from the original type, the one being represented by 'small steps,' the other by 'sudden leaps'; and I must repeat that I am unable to draw a line between them. If Gager[13] again points to de Vries's definition of mutation (that it causes true breeding), I hardly can call this a fair criticism or a fair understanding of my views, after I have expressly excluded this criterion.

In this last instance, and in a few others, Gager directly distorts what I am saying. I have said[14] that 'in the beginning of the experiments, they (the mutations or mutants) were throwing off additional mutants.' Gager[15] omits the words 'in the beginning of the experiments,' and quotes the sentence as if it was clearly implied that I meant to say that '*all* the mutants were throwing off additional mutants.' In fact, I did not mean to say 'all,' for this would not correspond to the facts; and the words 'in the beginning of the experiments' are essential for the proper understanding of the whole paragraph, and of my contention that the mutants did not breed true, namely, *in the beginning:* they bred true *later on, in consequence of the experiment,* which was the point I wanted to bring out.

Further, when I say[16] that 'the breeding of domestic races has *always* been regarded as a process analogous to the one in nature by which new species are produced,' 'always' does not mean: by everybody and at all times. If it is hinted at by Gager[17] that I possibly might have intended to include Linnaeus or

[11] *L. c.*, p. 87.

[12] *L. c.*, p. 747.

[13] *L. c.*, p. 88.

[14] *L. c.*, p. 747.

[15] *L. c.*, p. 86.

[16] *L. c.*, p. 747.

[17] *L. c.*, p. 87.

other pre-Darwinian writers, this is a display either of mental density or of something worse, for he understood quite well what I meant, as is seen by his own use of the word 'always' further on.[18]

My two main contentions are: *that de Vries's conception of elementary species is inadequate,* and *that elementary species breed true, not because they are the product of a peculiar kind of variation, called mutation, but because they have been subject to the processes of selection and separation.* These essential points in my criticism have been overlooked by Gager, and he is content to say, with regard to the first one, that nobody, except makers of dictionaries, knows what a species is. With regard to my second contention, he fails entirely to see that it is intimately connected with the first one, and has made no attempt to demonstrate that mutation is capable of producing true breeds *without the help of selection and segregation,* and that the latter two factors *do not play an essential part in de Vries's experiments.* For the rest, he only points to de Vries's definitions of terms, which I reject; he points to the facts represented by the experiments, which I accept, but consider unsatisfactory and incomplete; and he points to the value of the experimental method as the only one that is apt to decide questions of evolution, which I positively deny. Experiments are valuable, but they should be properly understood, and should be correctly explained. The interpretation of his experiments given by de Vries is faulty, although the experiments themselves are indisputable facts; and the fallacy is due to his ignorance of the fundamental laws of evolution, and to his incorrect conception of the term species: with the latter his theory stands and falls.[19]

I hope that this will be sufficient, even to Gager, to define my standpoint, and, if any further discussion should be considered necessary, that it will take up the essential points of my views, and not merely repeat the arguments of de Vries. Gager has done only this, in a way which clearly lacks understanding of what I really object to. If he further would consider the rule, not to throw stones at people out of a glass house, and observe the necessary fairness to others, this would make the discussion a more pleasant and profitable one.

[18] *L. c.*, p. 88, foot-note 65: 'Since the process has been recognized and described.'

[19] SCIENCE, June 22, 1906, p. 948.

A. E. ORTMANN.

CARNEGIE MUSEUM, PITTSBURG,
July 23, 1906.

SPECIAL ARTICLES.

HERBARIUM TYPE SPECIMENS IN PLANT MORPHOLOGY.

THE close relationship existing between the different branches of botany and the dependence of these various branches upon each other make it very important that every precaution should be taken by the workers of each branch to make their specialty as helpful as possible to all other divisions of the subject. With the advancement of each phase of the subject the points of relationship become more prominent and the necessity for the preservation of records, specimens, etc., becomes of greater and greater importance.

Between no two branches of botany is the necessity of cooperation greater than between taxonomy and morphology. The taxonomist has long recognized the importance of type specimens and large herbaria have been brought together and maintained at great expense where these types may be preserved and studied to the best advantage. The morphologist has probably in most cases preserved his microscopic specimens, but in how many cases has the morphologist prepared herbarium specimens of the species on which he is working? This custom may and probably is followed by many workers, but it is also true that many morphologists have not only neglected to preserve type material but in many instances have not even taken the precaution to have their determinations verified by specialists in taxonomy.

If morphological botany is to add anything to our knowledge of taxonomic botany, it appears to the writer that herbarium specimens should be carefully prepared, properly labeled,

and deposited in centers of botanical research where they may be consulted by future investigators in both taxonomy and morphology.

Some years since the writer made a morphological study of certain members of the family Nymphæaceæ and among them the northern *Nymphæa advena*. More recently I have made a study of certain tropical species of the same family and among them a species of the genus *Nymphæa*. This species showed such striking resemblances to the well-known species *N. advena*, that it was sent to specialists in taxonomy to verify the determination. The reports from these workers showed a difference of opinion; some claiming that it was a new species, while others claimed that it was a variety. However, the embryology showed certain very marked differences, which may be of sufficient importance to make it a distinct species. Had these two lots of material been studied by different workers, and considered as one species, or by one worker without having the specimens examined by taxonomists, the confusion might have been easily increased rather than diminished.

When we take into consideration the large number of families and genera which are still untouched by the morphologist we must naturally expect that future work will bring to light many new and important facts; and these facts will in turn present certain questions which will make it imperative that certain other species already studied should be restudied in the light of said new facts. It will then be very important that the investigator know positively whether the species in question is the same or merely closely related to the species studied by the first investigator. Johnson,[1] in his studies on Piperales, has recently called attention to the fact that closely related genera may show wide variations in the development of the tapetum, megaspore, embryo-sac and endosperm. From my studies in *Nymphæa* I am inclined to believe that we may also find wider variations between species of the same genera than we have supposed.

Under present conditions two workers in different localities working upon supposedly the same species may honestly present different results or the second may unintentionally and unjustly give expression to criticism on the results of the first worker.

Would it not be well for the plant morphologists at the next meeting of the American Association for the Advancement of Science to consider methods for cooperation and preservation of types.

Mel. T. Cook.
Estacion Central Agronomica,
Santiago de las Vegas, Cuba.

[1] Johnson, Johns Hopkins University Circular No. 178. May, 1905.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

The first meeting of the International Convention of the International Catalogue of Scientific Literature was held in London, July 25–26, 1905. The supreme control of the catalogue is vested in this body and in beginning the undertaking in 1900 it was agreed that its meetings should be held in London in 1905, in 1910 and thereafter every ten years. The following named delegates were present at the convention:

Austria—Professor Dr. August von Bohm, K. K. Hofbibliothek, Vienna.

Belgium—M. Paul Otlet (Secrétaire-General de l'Office International de Bibliographie, Brussels). M. H. La Fontaine (Directeur de l'Office International de Bibliographie, Brussels).

France—Professor G. Darboux (Secrétaire Perpétuel de l'Institut de France). Dr. J. Deniker (Bibliothécaire du Muséum d'Histoire Naturelle, Paris).

Germany—Professor Dr. O. Uhlworm (Director des Deutschen Regionalbureau).

Greece—His Excellency Mons D. Métaxas (Ministre Plénipotentaire de S. M. le Roi des Hellènes).

Holland—Professor D. J. Korteweg (University of Amsterdam).

India—Lieutenant-Colonel Prain, I.M.S., F.R.S.

Italy—Cav. Ernesto Mancini (Accademia dei Lincei, Rome). Professor Raffaello Nasini (University of Padua).

Japan—Professor K. Matsubara (University of Tokyo).

Mexico—His Excellency Don Francisco A. de Icaza.

Russia—Professor I. P. Borodin (Imperial Academy of Sciences, St. Petersburg).

South Africa—R. Trimen, Esq., F.R.S.

United Kingdom—Professor H. E. Armstrong, F.R.S. Professor J. Larmor, Secretary Royal Society. Dr. P. Chalmers Mitchell.

Smithsonian Institution—Dr. Leonhard Stejneger (United States National Museum).

Professor H. E. Armstrong having been appointed chairman of the convention, the following resolutions were passed:

On the motion of the chairman, seconded by Dr. Stejneger, it was *Resolved:* That, in view of the success already achieved by the International Catalogue of Scientific Literature and of its great importance to scientific workers, it is imperative to continue the publication of the catalogue at least for a further period of five years.

On the motion of the chairman it was *Resolved:* That the convention approves of the proposal for an amalgamation of the *Zoological Record* published by the Zoological Society of London with Volume N of the International Catalogue in accordance with paragraph 24 of the Report, p. 10, and authorizes the executive committee to carry the proposal into effect.

On the motion of Dr. Stejneger it was *Resolved:* That it is the desire of this convention that the executive committee, as soon as practicable, take into consideration the question of issuing cards.

On the motion of Dr. Stejneger, seconded by Dr. Deniker, it was *Resolved:* That the report of the committee of schedules be adopted.

On the motion of the chairman it was *Resolved:* That the report of the executive committee be adopted and that all matters therein not dealt with by this convention be remitted to the executive committee with power to act thereon.

The report of the executive committee to the international convention covered some twenty-three pages and contained the following statements of interest:

* * * It appears that the date originally contemplated for the completion of the fifth issue (1906) will be exceeded by about six months only. Taking into account the delay which arose in the organization of the work by the regional bureaus, which involved the postponement of the publication of the first annual issue by almost a year, if the result contemplated be achieved, a most satisfactory conclusion of the first stage of the enterprise will have been arrived at in so far as the issue of the printed catalogue is concerned.

REGIONAL BUREAUS.

At the present time Bureaus are established in thirty-two separate regions. The only countries which have not yet established bureaus are Servia and Bulgaria, in Europe, and the South American states. Spain has joined during this year.

Taking into account the character of the enterprise, the successful manner in which the collection of the material has been organized, and the care with which the indexing has been accomplished are little short of remarkable, and reflects the greatest credit on all concerned.

Necessarily there have been very many difficulties connected with a work of such intricacy carried on in various countries by independent organizations; but so great has been the desire to accomplish the work, that these have all been met without the slightest disagreement arising.

It is surprising to what an extent it has been possible for the various bureaus to make use of the schedules provided by the international conference which authorized the enterprise: Obviously in such a case only experience could lead to the establishment of a common system of indexing likely to give general satisfaction.

EXTENSION OF THE ENTERPRISE.

At the meeting of the International Council in May last year, a proposal to extend the scope of the catalogue by the publication of additional series of volumes dealing with such subjects as—(*a*) medicine and surgery, (*b*) agriculture, horticulture and forestry and (*c*) technology (various branches), was discussed and the opinion expressed that it was desirable that the executive committee should take the matter into further consideration in order that it may be brought under notice at the meeting of the convention this year.

After considering this question fully and discussing it with those interested in the work of the catalogue, the executive committee are of opinion that it is undesirable at present to extend the scope of the catalogue. It would be unwise to increase the responsibility of the organization so long as it is not in possession of an adequate working capital. Moreover, it is desirable that the energies of the bureaus should be directed, at all events during the next few years, to perfecting the catalogue in order that it may render all the assistance that was contemplated at its inception to scientific workers in those subjects which, after much discussion, were selected for treatment.

In order to give the work its necessary completeness, the indexing of scientific communications must be carried beyond the mere titles to a far greater extent than has hitherto been the case.

Marked progress in this direction is taking place, but until the cooperation of authors and publishing bodies has been secured it will always be difficult for the bureaus to deal effectively with the literature which they are required to index. The collection of the necessary subject-matter should become automatic in proportion as effective action is taken to secure the proper indexing of papers at the time of issue; at the same time the cost to the regional bureaus should be reduced in a corresponding manner.

At the meeting of the International Association of Academies in London last year, it was resolved to ask the several constituent academies to cooperate in the production of the catalogue in their several countries by securing the indexing of scientific journals at the time of issue. The central bureau is satisfied that it is imperative that the several regional bureaus should in every way exert their influence in order to bring about such cooperation between publishing bodies generally and the International Catalogue of Scientific Literature.

Assuming the catalogue to be established as a permanent enterprise, it can not fail to exercise an influence in various directions on the work of scientific inquiry. The suggestion has already been made to the central bureau that it should be prepared to give information as to the state of knowledge in particular subjects—as is already done, for example, by the authorities of the Bibliographia Zoologica in Zurich. The inclusion on the staff of the central bureau of persons able to collate such information would add much to its efficiency, and it is to be hoped that it may be possible at no distant date.

For such a purpose and in the general interests of scientific workers, it is desirable, moreover, not only that the central bureau should be provided with lists of new species but also that physical constants should be recorded on special slips in order that complete lists of such data may be tabulated.

Another suggestion which has been made to the central bureau is that at the end of ten years a decennial index of each subject should be prepared, which, if not a reproduction of the ten separate volumes, should be at least a key to them.

The present price of each annual issue is fixed at seventeen pounds to contracting bodies. Although it is most important that the price should be reduced, it is not possible, at present, to take any steps in this direction. But it will be desirable to authorize the executive committee to make reductions whenever this becomes possible.

The originators of the catalogue always looked forward to the amalgamation of their enterprise with some of the existing agencies by which scientific literature is indexed, often at a considerable cost and with far more limited opportunities for collecting the necessary material than are now at the disposal of the International Catalogue. The executive committee have, therefore, great pleasure in recommending that during the period 1906–1910 the publication of the zoology catalogue be carried out in conjunction with the Zoological Society of London, by whom, during the past forty years, the well-known index of zoological literature, *The Zoological Record*, has been issued.

The agreement would be that the volumes are issued with a double title page, as volumes of the International Catalogue and as volumes of the *Zoological Record*, in both cases appropriately numbered in continuation with the volumes already issued. The cost of printing and publishing would be charged to the International Catalogue, together with a sum equal to that hitherto expended by the central bureau on special expert assistance. All further costs on account of the revision and arrangement of the material would be borne by the Zoological Society. The International Catalogue would receive the proceeds of all subscriptions and sales. The Zoological Society would appoint a committee of experts to prepare for press the material supplied by the central bureau. The committee of experts would be responsible for the scientific accuracy of the volume, whilst the central bureau would see that the volumes are produced in general accordance with the principles adopted in the catalogue as a whole.

SCHEDULES.

The schedules accepted for use during the first period of five years have been found in practise to answer remarkably well, except in the case of physics, which has proved to be far too narrow in its provisions.

A proposal to issue the zoology volumes in parts has been made. It appears desirable to adopt this proposal; the experience gained in connection with this subject will be of value in determining whether a similar course should be adopted in regard to other volumes.

SCIENTIFIC NOTES AND NEWS.

The British Association for the Advancement of Science will meet next year at Lei-

cester, beginning on July 31. The meeting the following year will be in Dublin, and in 1909 the association will for the third time visit Canada and meet in Winnipeg.

THE University of Leeds has conferred the degree of D.Sc. on the following in connection with the York meeting of the British Association: Professor Ray Lankester, F.R.S., president of the association; Professor Alfred Grandilier, of Paris; Professor Paul Pelseneer, of Ghent; and Professor Heinrich Ruebens, of Berlin. It has further conferred the degree on the following in connection with the meeting of the association and also with the coal-tar color jubilee: Sir W. H. Perkin; Dr. Heinrich Caro, of Mannheim; Professor Albin Haller, of Paris; Professor C. Liebermann, of Berlin, and Dr. C. A. von Martins, of Berlin.

THE London correspondent of the New York *Evening Post* cables: "The sudden compulsory retirement of Ray Lankester from the directorship of the Museum of Natural History on an inadequate pension arouses general condemnation. Mr. Lankester, as testified by his presidency this year over the British Association, has rendered conspicuous services to science. The *Times* says that in any country but this it would be thought grotesque that a distinguished man of science should be treated on the same footing as an ordinary civil service clerk. No explanation has yet been vouchsafed of the cavalier treatment which Mr. Lankester has received."

WE learn from *Nature* that Sir William Crookes, Professor Eduard Suess, Professor Luigi Palazzo and Professor Orazio Marucchi were elected honorary members of the Royal Academy of Acireale (Sicily) at a meeting on July 24.

PROFESSOR CHARLES FLAHAUT, of Montpelier, has been elected an honorary member of the Zoological and Botanical Society of Vienna.

DR. GUSTAV TSCHERMAK, professor of mineralogy and petrography at Vienna, has retired from active service.

MR. GERRIT S. MILLER, JR., assistant curator, division of mammals, U. S. National Museum, has been granted a year's furlough from the museum in order to engage in a biological survey of southwestern Europe. Dr. M. W. Lyon, Jr., has been appointed temporarily assistant curator during Mr. Miller's absence.

DR. ARTHUR HOLLICK, of the New York Botanical Garden, and Professor Edward C. Jeffrey, of Harvard University, have been making studies of the Cretaceous fossil flora of New Jersey and Marthas Vineyard for a joint work on the subject.

DR. FRANK P. WHITMAN, professor of physics at Western Reserve University, will represent the university at the celebration of the University of Aberdeen in September. He attended the York meeting of the British Association.

MR. ALFRED MOSELY will sail for New York on October 10, to assist in making arrangements for the reception of the parties of English teachers that will come to this country during the winter under his auspices. The first party of teachers, numbering about thirty, will sail for the United States on November 30, and thereafter similar parties will sail weekly.

PROFESSOR SAMUEL LEWIS PENFIELD, head of the Department of Mineralogy in the Sheffield Scientific School of Yale University, died at Woodstock, Conn., on August 14, aged fifty years.

MR. GUSTAV WILLIAM LEHMANN, chemist of the U. S. government since 1878 and chief chemist of the Baltimore Board of Health since 1896, died on August 5. Mr. Lehmann was born in Wiesbaden in 1844, and was known for his work on the electrolytic deposition of copper and on the chemistry and bacteriology of food products. He was a fellow of the American Association for the Advancement of Science and a member of the American Chemical Society and the American Institute of Mining Engineers.

DR. WALTER NGON FONG, president of the Li Shing Scientific and Industrial College of Hongkong, died of the plague at Hongkong on May 12 of this year. Dr. Fong was the first Chinese graduate of Stanford University, and was for a time instructor in the University of California. He was one of the ablest

of the Chinese who have been educated in America, and as the head of this new college was exerting a very great influence toward the modernization of Chinese education. He will be remembered as the author of an article on 'Education in China' in the *Popular Science Monthly* in 1905.

Sir John Brunner has given £5,000 towards the completion and equipment of the additional buildings for engineering, metrology and metallurgy now in course of erection at the National Physical Laboratory.

Dr. R. C. Brown, of Preston, Lancashire, has placed at the disposal of the committee for the study of special diseases of the University of Cambridge the sum of £150 per annum for two years, for a pathological scholarship in connection with the investigations now being carried out by the committee on rheumatoid arthritis and allied diseases.

The government steamer *Arctic* has sailed from Quebec for northern latitudes *via* Greenland. She will winter in Lancaster Sound.

The series of stereoscopic cards to accompany the exercises in Titchener's 'Experimental Psychology' has now been published and may be obtained of the Chicago Laboratory Supply Company. Indicative of the interest in this topic as an aid to instruction in psychology is the announcement in the catalogue of Henry Holt and Company of a manual with accompanying photographic illustrations, on 'The Psychology of Stereoscopic Vision.' The author is Professor Jastrow, of the University of Wisconsin.

We learn from the *Geographical Journal* that a schedule has been drawn up by the International Statistical Institute, which is intended to serve as a guide to those who may be in a position to undertake demographical research in uncivilized countries. The principal points on which information is desired are grouped under thirty-five sections, while useful hints are given whereby the inquiry may be carried out to the best advantage. It is suggested that, where possible, enumerations of the population of suitably selected areas may be made, and forms are drawn up for the record of the data on the basis either of the household or the individual. When such inquiries are carried out by individuals, it is asked that the returns be sent to the office of the institute at Rome.

Nature states that the Institute of Chemistry has published a 'List of Official Chemical Appointments held in Great Britain and Ireland, in India and the Colonies.' The list has been compiled under the supervision of the proceedings committee of the institute by Mr. R. B. Pilcher, the secretary of the institute, and its price is 2s. net. The list is arranged in two main divisions: the first contains appointments under the departments of state and professorial appointments in the British Isles; the second section deals similarly with India and the colonies.

The *Electrical World* states that a company has been formed at Berlin having for its object a series of experiments with motor airships. The Emperor's influence directly brought about the movement to make a systematic investigation of air navigation, and, with practically unlimited capital, to experiment with motor airships. Admiral von Hollman was elected president of the company. The directors are Herr Rathenau, Dr. Althoff, director of the Ministry of Public Worship and Instruction; Ernst Borsig, a manufacturer of locomotives; Baron von Brandenstein, Ludwig Delbrueck, Herr Schwabach, of the Bleichroeder Bank, Herr Loewe, of the Mauser Rifle Company, Wilhelm von Siemens, James Simon and N. T. Boettinger. Captain Richard von Kaehler, an engineer of repute, was elected business manager.

We learn from *The Condor* that the Audubon Society of California was formally organized at the Los Angeles Chamber of Commerce on May 31, 1906. This regular state organization will cooperate with the National Committee of Audubon Societies at New York, and also have general supervision over the work of the local societies. An important meeting is planned for the early autumn, when

a definite plan of work will be decided upon. The officers elected at the initial meeting are: *President,* Dr. David Starr Jordan; *Vice-presidents,* Professor C. F. Holder and Dr. F. W. D'Evelyn; *Secretary,* W. Scott Way.

As we have already announced, the British Medical Association will hold its seventy-fourth annual meeting this year in Toronto. From the program, as published in the English journals, we note that thirteen scientific sections have been arranged, and will meet daily in the university buildings at 9:30 A.M., namely, anatomy, dermatology, laryngology and otology, medicine, obstetrics and gynecology, ophthalmology, pediatrics, pathology and bacteriology, physiology, psychology, state medicine, surgery, and therapeutics. On Tuesday, August 21, at 2:30 P.M., an address of welcome will be accorded to members, and the ceremony of introducing the distinguished guests and delegates will be performed. This will be immediately followed by the presidential address by Professor Reeve. At 4:30 P.M., in the university quadrangle, a reception and garden party by the president and Mrs. Reeve. At 8:30 an address in obstetrics will be delivered by Dr. W. S. A. Griffith, of London, while at 9:30 the lieutenant-governor will receive the members of the association. On Wednesday, at 2:30 P.M., an address in medicine will be delivered by Sir James Barr, of Liverpool; and in the afternoon various garden parties have been arranged. In the evening, at 8:30, an address in surgery will be delivered by Sir Victor Horsley, and this will be followed by a reception, at 9:30 P.M. On Thursday afternoon garden parties have also been arranged, while at 7:30 P.M. the president will preside at the annual dinner, when a most distinguished gathering is assured. On Friday afternoon extensive entertainments are promised to members and their friends, while in the evening will be held a grand *soirée.* On Saturday several excursions are arranged—to Niagara Power Company's plant, through the courtesy of Sir Henry M. Pellat; to Muskoka; and to Lambton, through the courtesy of the president, Mr. Austin.

THE London *Times* states that Mr. Sinclair, M.P., secretary for Scotland, received in Edinburg, on July 1, deputations from the Royal Society of Edinburgh and the Royal Scottish Geographical Society. The former urged the claims of science in the readjustment of grants in aid and in the allocation of national buildings contemplated in the National Galleries Bill. In the bill, it was maintained no mention whatever was made of science. The financial clauses of the bill might, and probably would, be limited in their application to art and to existing buildings. No direct provision was made for the representation of science on the new board of trustees, as was recommended by the departmental committee. The new trustees might allocate the whole of the buildings on the Mound to art and evict the Royal Society of Edinburgh. Lord McLaren, vice-president, stated the case on behalf of the society, and was supported by Mr. J. W. Gulland, M.P., Principal Sir William Turner, Principal McKay, Dundee University College; Professor Cash, Aberdeen University; Professor Gray, Glasgow University, and Professor Chrystal, secretary of the society. All pointed to the important place occupied by the Royal Society of Edinburgh as a national institution devoted to scientific research. The secretary for Scotland, in his reply, said he recognized most fully that the work of the Royal Society was a national one. The proposals of the government with regard to the buildings at the Mound were to use the south building as the National Gallery, and in the building next Princes Street, known as the Royal Institution, to house the Royal Scottish Academy. The effect of that rearrangement was that the Royal Society would no longer find accommodation in the Royal Institution buildings; but the government was prepared to meet the reasonable demands of the society in a liberal spirit. He asked them to prepare a scheme for his consideration. He refused to commit himself to an alternative scheme, whereby the Royal Society and other scientific bodies in Edinburgh would combine under one roof, though he was ready to consider any proposal put before him, provided the financial arrangements were reasonable. To the deputation of

the Royal Scottish Geographical Society, who asked for representation on the board of trustees for the National Gallery and a grant from the government, Mr. Sinclair said the bill was wholly concerned with national galleries, and had no reference to scientific bodies. Apart from the question whether government assistance was possible or probable, he stated that government assistance carried with it the disadvantage of government control.

UNIVERSITY AND EDUCATIONAL NEWS.

The will of the late Horace M. Potts bequeathes $5,000 to the Hospital of the University of Pennsylvania for the endowment of a free bed, and $10,000 to the Orphans' Home and Asylum for the Aged Insane of the Lutheran Church. Most of the remainder of his estate, valued at $75,000, is divided between the Philadelphia Academy of Natural Sciences and the University of Pennsylvania.

Mr. Andrew Carnegie has promised $30,000 to Hamline University, St. Paul, Minn., for a library building, on condition that the same amount be raised for its maintenance, which amount is at the present time nearly in hand. The building will probably be begun in the course of the next month or two.

Suit has been instituted in the Supreme Court of the District of Columbia to compel the Catholic University of America to relinquish securities aggregating $876,168 said to have been given the university by the late Thomas E. Waggaman a short time before proceedings in bankruptcy were begun against him. The plaintiffs declare that Waggaman permitted the attorneys for the Catholic University, to which he was indebted to the extent of about $900,000, to select choice securities to cover his indebtedness to the institution, although it was his duty to keep all securities intact so that the complainants, as well as the university and other creditors, might have an equitable lien without priority discrimination.

Towards the cost of extending the Union buildings and the furnishing and equipment of the library of Edinburgh University Sir Donald Currie and Mr. Andrew Carnegie have each offered to contribute £6,000, provided £6,000 more is raised locally.

The senate of London University has received from Mr. Martin White two further donations—one to provide a salary of £200 a year for Dr. Edward Westermarck, university lecturer in sociology, for a further period of five years, the other an additional sum of £700 for the establishment for five years of two scholarships a year each of the annual value of £35 and tenable for two years. In connection with Mr. White's benefaction, special courses will be delivered during the session 1906–7 on ethnology by Dr. A. C. Haddon, F.R.S., and on psychology by Dr. J. W. Slaughter, Ph.D. (Clark).

The Medical College of Indiana, the Central College of Physicians and Surgeons and the Fort Wayne College of Medicine have become one, and as such have become a part of Purdue University under the name, 'Indiana Medical College, the School of Medicine of Purdue University.'

It is proposed to establish a chair of geography in the University of Edinburgh.

A readership in meteorology has been instituted in London University.

The council of Nottingham University College has decided to apply for a university charter. The college, which is now in its twenty-fifth year, has over 2,000 students.

The new science buildings of Glasgow University will be opened in the spring of next year by the Prince of Wales.

Mr. Alexander Mackie, M.A., assistant lecturer in education and in philosophy, Bangor University College, has been appointed assistant professor of education in Edinburgh University.

Dr. James P. Hill, late demonstrator in biology and lecturer on embryology in the University of Sydney, has been appointed to the Jodrell chair of zoology in University College, London.

Dr. R. A. Raiss has been appointed associate professor of scientific photography at Lausanne.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 24, 1906.

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INAUGURAL ADDRESS BEFORE THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.[1]

UNDER the title 'Darwinism' it is convenient to designate the various work of biologists tending to establish, develop or modify Mr. Darwin's great theory of the origin of species. In looking back over twenty-five years it seems to me that we must say that the conclusions of Darwin as to the origin of species by the survival of selected races in the struggle for existence are more firmly established than ever. And this because there have been many attempts to gravely tamper with essential parts of the fabric as he left it, and even to substitute conceptions for those which he endeavored to establish, at variance with his conclusions. These attempts must, I think, be considered as having failed. A great deal of valuable work has been done in consequence; for honest criticism, based on observation and experiment, leads to further investigation, and is the legitimate and natural mode of increase of scientific knowledge. Amongst the attempts to seriously modify Darwin's doctrine may be cited that to assign a great and leading importance to Lamarck's theory as to the transmission by inheritance of newly 'acquired' characters, due chiefly to American paleontologists and to the venerated defender of such views, who has now closed his long life of great work, Mr. Herbert Spencer; that to attribute leading importance to the action of physiological con-

[1] Concluding part of the address given by Dr. E. Ray Lankester, at York, on August 1, 1906.

gruity and incongruity in selective breeding, which was put forward by another able writer and naturalist who has now passed from among us, Dr. George Romanes; further, the views of de Vries as to discontinuity in the origin of new species, supported by the valuable work of Mr. Bateson on discontinuous variation; and lastly, the attempt to assign a great and general importance to the facts ascertained many years ago by the Abbé Mendel as to the cross-breeding of varieties and the frequent production (in regard to certain characters in certain cases) of pure strains rather than of breeds combining the characters of both parents. On the other hand, we have the splendid series of observations and writings of August Weismann, who has in the opinion of the majority of those who study this subject rendered the Lamarckian theory of the origin and transmission of new characters altogether untenable, and has, besides, furnished a most instructive, if not finally conclusive, theory or mechanical scheme of the phenomena of heredity in his book, 'The Germ-plasm.' Professor Karl Pearson and the late Professor Weldon—the latter so early in life and so recently lost to us—have, with the finest courage and enthusiasm in the face of an enormous and difficult task, determined to bring the facts of variation and heredity into the solid form of statistical statement, and have organized, and largely advanced in, this branch of investigation, which they have termed 'Biometrics.' Many naturalists throughout the world have made it the main object of their collecting and breeding of insects, birds and plants, to test Darwin's generalizations and to expand the work of Wallace in the same direction. A delightful fact in this survey is that we find Mr. Alfred Russel Wallace (who fifty years ago conceived the same theory as that more fully stated by Darwin) actively working and publishing some of the most convincing and valuable works on Darwinism. He is still alive and not merely well, but pursuing his work with vigor and ability. It was chiefly through his researches on insects in South America and the Malay Islands that Mr. Wallace was led to the Darwinian theory; and there is no doubt that the study of insects, especially of butterflies, is still one of the most prolific fields in which new facts can be gathered in support of Darwin and new views on the subject tested. Prominent amongst naturalists in this line of research has been and is Edward Poulton, of Oxford, who has handed on to the study of entomology throughout the world the impetus of the Darwinian theory. I must here also name a writer who, though unknown in our laboratories and museums, seems to me to have rendered very valuable service in later years to the testing of Darwin's doctrines and to the bringing of a great class of organic phenomena within the cognizance of those naturalists who are especially occupied with the problems of variation and heredity. I mean Dr. Archdall Reid, who has with keen logic made use of the immense accumulation of material which is in the hands of medical men, and has pointed out the urgent importance of increased use by Darwinian investigators of the facts as to the variation and heredity of that unique animal, man, unique in his abundance, his reproductive activity, and his power of assisting his investigator by his own record. There are more observations about the variation and heredity of man and the conditions attendant upon individual instances than with regard to any other animal. Medical men need only to grasp clearly the questions at present under discussion in order to be able to furnish with ease data absolutely invaluable in quantity and quality. Dr. Archdall Reid has in two original books full of insight and new suggestions, the 'Present

Evolution of Man' and 'Principles of Heredity,' shown a new path for investigators to follow.

The attempt to resuscitate Lamarck's views on the inheritance of acquired[2] characters has been met not only by the demand for the production of experimental proof that such inheritance takes place, which has never been produced, but on Weismann's part by a demonstration that the reproductive cells of organisms are developed and set aside from the rest of the tissues at so early a period that it is extremely improbable that changes brought about in those other tissues by unaccustomed incident forces can be communicated to the germ-cells so as to make their appearance in the offspring by heredity. Apart from this, I have drawn attention to the fact that Lamarck's first and second laws (as he terms them) of heredity are contradictory the one of the other, and therefore may be dismissed. In 1894 I wrote:

> Normal conditions of environment have for many thousands of generations moulded the individuals of a given species of organism, and determined as each individual developed and grew 'responsive' quantities in its parts (characters); yet, as Lamarck tells us, and as we know, there is in every individual born a potentiality which has *not* been extinguished. Change the normal conditions of the species in the case of a young individual taken to-day from the site where for thousands of generations its ancestors have responded in a perfectly defined way to the normal and defined conditions of environment; reduce the daily or the seasonal amount of solar radiation to which the individual is exposed; or remove the aqueous vapor from the atmosphere; or alter the chemical composition of the pabulum accessible; or force the individual to previously unaccustomed muscular effort or to new pressures and strains; and (as Lamarck bids us observe), in spite of all the long-continued response to the earlier normal specific conditions, the innate congenital potentiality shows itself. The individual under the new quantities of environing agencies shows *new* responsive quantities in those parts of its structure concerned, new or *acquired* characters.

So far, so good. What Lamarck next asks us to accept, as his 'second law,' seems not only to lack the support of experimental proof, but to be inconsistent with what has just preceded it. The new character which is *ex hypothesi*, as was the old character (length, breadth, weight of a part) which it has replaced—a response to environment, a particular moulding or manipulation by incident forces of the potential congenital quality of the race—is, according to Lamarck, all of a sudden raised to extraordinary powers. The new or freshly acquired character is declared by Lamarck and his adherents to be capable of transmission by generation; that is to say, it alters the potential character of the species. It is no longer a merely responsive or reactive character, determined quantitatively by quantitative conditions of the environment, but becomes fixed and incorporated in the potential of the race, so as to persist when other quantitative external conditions are substituted for those which originally determined it. In opposition to Lamarck, one must urge, in the first place, that this thing has never been shown experimentally to occur; and in the second place, that there is no ground for holding its occurrence to be probable, but, on the contrary, strong reason for holding it to be improbable. Since the old character (length, breadth, weight) had not become fixed and congenital after many thousands of successive generations of individuals had developed it in response to environment, but gave place to a new character when new conditions operated on an individual (Lamarck's first law), why should we suppose that the new character is likely to become fixed after a much shorter time of responsive existence, or to escape the operation of the first law? Clearly there is no reason (so far as Lamarck's statement goes) for any such supposition, and the two so-called laws of Lamarck are at variance with one another.

In its most condensed form my argument has been stated thus by Professor Poulton: Lamarck's "first law assumes that a past history of indefinite duration is powerless to create a bias by which the present can be controlled; while the second assumes that the brief history of the present can readily raise a bias to control the future" (*Nature*, Vol. LI., 1894, p. 127).

[2] I use the term 'acquired' without prejudice in the sense given to that word by Lamarck himself.

An important light is thrown on some facts which seem at first sight to favor the Lamarckian hypothesis by the consideration that, though an 'acquired' character is not transmitted to offspring as the consequence of the action of external agencies determining the 'acquirement,' yet the tendency to react exhibited by the parent *is* transmitted, and if the tendency is exceptionally great a false suggestion of a Lamarckian inheritance can readily result. This inheritance of 'variation in tendencies to react' has a wide application, and has led me to coin the word 'educability' as mentioned in the section of this address on psychology.

The principle of physiological selection advocated by Dr. Romanes does not seem to have caused much discussion, and has been unduly neglected by subsequent writers. It was ingenious, and was based on some interesting observations, but has failed to gain support.

The observations of de Vries—showing that in cultivated varieties of plants a new form will sometimes assert itself suddenly and attain a certain period of dominance, though not having been gradually brought into existence by a slow process of selection—have been considered by him, and by a good many naturalists, as indicating the way in which new species arise in nature. The suggestion is a valuable one if not very novel, but a great deal of observation will have to be made before it can be admitted as really having a wide bearing upon the origin of species. The same is true of those interesting observations which were first made by Mendel, and have been resuscitated and extended with great labor and ingenuity by recent workers, especially in this country by Bateson and his pupils. If it should prove to be true that varieties when crossed do not, in the course of eventual interbreeding, produce intermediate forms as hybrids, but that characters are either dominant or recessive, and that breeds result having pure unmixed characters—we should, in proportion as the Mendelian law is shown to apply to all tissues and organs and to a majority of organisms, have before us a very important and determining principle in all that relates to heredity and variation. It remains, however, to be shown how far the Mendelian phenomenon is general. And it is, of course, admitted on all sides that, even were the Mendelian phenomenon general and raised to the rank of a law of heredity, it would not be subversive of Mr. Darwin's generalizations, but probably tend to the more ready application of them to the explanation of many difficult cases of the structure and distribution of organisms.

Two general principles which Mr. Darwin fully recognized appear to me to deserve more consideration and more general application to the history of species than he had time to give to them, or than his followers have accorded to them. The first is the great principle of 'correlation of variation,' from which it follows that, while natural selection may be favoring some small and obscure change in an unseen group of cells—such as digestive, pigmentary or nervous cells, and that change a change of selective value—there may be, indeed often is, as we know, a correlated or accompanying change in a physiologically related part of far greater magnitude and prominence to the eye of the human onlooker. This accompanying or correlated character has no selective value, is not an adaptation—is, in fact, a necessary but useless by-product. A list of a few cases of this kind was given by Darwin, but it is most desirable that more should be established. For they enable us to understand how it is that specific characters, those seen and noted on the surface by systematists, are not in most cases adaptations of selective value. They also open a wide vista of

incipient and useless developments which may suddenly, in their turn, be seized upon by ever-watchful natural selection and raised to a high pitch of growth and function.

The second, somewhat but by no means altogether neglected, principle is that a good deal of the important variation in both plants and animals is not the variation of a minute part or confined to one organ, but has really an inner physiological basis, and may be a variation of a whole organic system or of a whole tissue expressing itself at several points and in several shapes. In fact, we should perhaps more generally conceive of variation as not so much the accomplishment and presentation of one little mark or difference in weight, length or color, as the expression of a *tendency to vary* in a given tissue or organ in a particular way. Thus we are prepared for the rapid extension and dominance of the variation if once it is favored by selective breeding. It seems to me that such cases as the complete disappearance of scales from the integument of some osseous fishes, or the possible retention of three or four scales out of some hundreds present in nearly allied forms, favor this mode of conceiving of variation. So also does the marked tendency to produce membranous expansions of the integument in the bats, not only between the digits and from the axilla, but from the ears and different regions of the face. Of course, the alternative hairy or smooth condition of the integuments both in plants and animals is a familiar instance in which a tendency extending over a large area is recognized as that which constitutes the variation. In smooth or hairy varieties we do not postulate an individual development of hairs subjected one by one to selection and survival or repression.

The study of the physiology of unhealthy, injured or diseased organisms is called pathology. It necessarily has an immense area of observation and is of transcending interest to mankind, who do not accept their diseases unresistingly and die as animals do, so purifying their race, but incessantly combat and fight disease, producing new and terrible forms of it by their wilful interference with the earlier rule of nature.

Our knowledge of disease has been enormously advanced in the last quarter of a century, and in an important degree our power of arresting it, by two great lines of study going on side by side and originated, not by medical men nor physiologists in the narrow technical sense, but by naturalists, a botanist and a zoologist. Ferdinand Cohn, professor of botany in Breslau, by his own researches and by personal training in his laboratory, gave to Robert Koch the start on his distinguished career as a bacteriologist. It is to Metchnikoff, the zoologist and embryologist, that we owe the doctrine of phagocytosis and the consequent theory of immunity now so widely accepted.

We must not forget that in this same period much of the immortal work of Pasteur on hydrophobia, of Behring and Roux on diphtheria, and of Ehrlich and many others, to whom the eternal gratitude of mankind is due, has been going on. It is only some fifteen years since Calmette showed that if cobra poison were introduced into the blood of a horse in less quantity than would cause death, the horse would tolerate with little disturbance after ten days a full dose, and then day after day an increasing dose, until the horse without any inconvenience received an injection of cobra poison large enough to kill thirty horses of its size. Some of the horse's blood being now withdrawn was found to contain a very active antidote to

cobra poison—what is called an antitoxin. The procedure and preparation of the antitoxin is practically the same as that previously adopted by Behring in the preparation of the antitoxin of diphtheria poison. Animals treated with injections of these antitoxins are immune to the poison itself when subsequently injected with it, or, if already suffering from the poison (as, for instance, by snake-bite), are readily shown by experiment to be rapidly cured by the injection of the appropriate antitoxin. This is, as all will admit, an intensely interesting bit of biology. The explanation of the formation of the antitoxin in the blood and its mode of antagonizing the poison is not easy. It seems that the antitoxin is undoubtedly formed from the corresponding toxin or poison, and that the antagonism can be best understood as a chemical reaction by which the complex molecule of the poison is upset, or effectively modified.

The remarkable development of Metchnikoff's doctrine of phagocytosis during the past quarter of a century is certainly one of the characteristic features of the activity of biological science in that period. At first ridiculed as 'Metchnikoffism,' it has now won the support of its former adversaries.

For a long time the ideal of hygienists has been to preserve man from all contact with the germs of infection, to destroy them and destroy the animals conveying them, such as rats, mosquitoes and other flies. But it has now been borne in upon us that, useful as such attempts are, and great as is the improvement in human conditions which can thus be effected, yet we can not hope for any really complete or satisfactory realization of the ideal of escape from contact with infective germs. The task is beyond human powers. The conviction has now been arrived at that, while we must take every precaution to diminish infection, yet our ultimate safety must come from within—namely, from the activity, the trained, stimulated and carefully guarded activity, of those wonderful colorless amœba-like corpuscles whose use was so long unrecognized, but has now been made clear by the patiently continued experiments and arguments of Metchnikoff, who has named them 'phagocytes.' The doctrine of the activity and immense importance of these corpuscles of the living body which form part of the all-pervading connective tissues and float also in the blood, is in its nature and inception opposed to what are called the 'humoral' and 'vitalistic' theories of resistance to infection. Of this kind were the beliefs that the *liquids* of the living body have an inherent and somewhat vague power of resisting infective germs, and even that the mere living quality of the tissues was in some unknown way antagonistic to foreign intrusive disease-germs.

The first eighteen years of Metchnikoff's career, after his undergraduate course, were devoted to zoological and embryological investigations. He discovered many important facts, such as the alternation of generations in the parasitic worm of the frog's lung—*Ascaris nigrovenosa*—and the history of the growth from the egg of sponges and medusæ. In these latter researches he came into contact with the wonderfully active cells, or living corpuscles, which in many low forms of life can be seen by transparency in the living animal. He saw that these corpuscles (as was indeed already known) resemble the well-known amœba, and can take into their soft substance (protoplasm) at all parts of their surface any minute particles and digest them, thus destroying them. In a transparent water-flea Metchnikoff saw these amœba-like, colorless, floating blood-cor-

puscles swallowing and digesting the spores of a parasitic fungus which had attacked the water-fleas and was causing their death. He came to the conclusion that this is the chief, if not the whole, value of these corpuscles in higher as well as lower animals, in all of which they are very abundant. It was known that when a wound bringing in foreign matter is inflicted on a vertebrate animal the blood-vessels become gorged in the neighborhood and the colorless corpuscles escape through the walls of the vessels in crowds. Their business in so doing, Metchnikoff showed, is to eat up the foreign matter, and also to eat up and remove the dead, wounded tissue. He, therefore, called these white or colorless corpuscles 'phagocytes,' the eater-cells, and in his beautiful book on 'Inflammation,' published twenty years ago, proved the extreme importance of their activity. At the same time he had shown that they eat up intrusive bacteria and other germs; and his work for the last twenty years has mainly consisted in demonstrating that they are the chief, and probably the only, agents at work in either ridding the human body of an attack of disease-causing germs or in warding off even the commencement of an attack, so that the man or animal in which they are fully efficient is 'immune'—that is to say, can not be effectively attacked by disease-germs.

Disease-germs, bacteria or protozoa produce poisons which sometimes are too much for the phagocytes, poisoning them and so getting the upper hand. But, as Metchnikoff showed, the training of the phagocytes by weak doses of the poison of the disease-germ, or by weakened cultures of the disease-germ itself, brings about a power of resistance in the phagocytes to the germ's poison, and thus makes them capable of attacking the germs and keeping them at bay. Hence the value of inoculations.

The discussion and experiments arising from Metchnikoff's demonstrations have led to the discovery of the production by the phagocytes of certain exudations from their substance which have a most important effect in weakening the resistance of the intrusive bacteria and rendering them easy prey for the phagocyte. These are called 'sensitizers,' and have been largely studied. They may be introduced artificially into the blood and tissues so as to facilitate the work of the phagocytes, and no doubt it is a valuable remedial measure to make use of such sensitizers as a treatment. Sir A. E. Wright considers that such sensitizers are formed in the blood and tissues independently of the phagocytes, and has called them 'opsonins,' under which name he has made most valuable application of the method of injecting them into the body so as to facilitate the work of the phagocytes in devouring the hostile bacteria of various diseases. Each kind of disease-producing microbe has its own sensitizer or opsonin; hence there has been much careful research and experiment required in order to bring the discovery to practical use. Metchnikoff himself holds and quotes experiments to show that the 'opsonins' are actually produced by the phagocytes themselves. That this should be so is in accordance with some striking zoological facts, as I pointed out nearly twenty years ago. For the lowest multicellular animals provided with a digestive sac or gut, such as the polyps, have that sac lined by digestive cells which have the same amœboid character as 'phagocytes,' and actually digest to a large extent by swallowing or taking into their individual protoplasm raw particles of food. Such particles are enclosed in a temporary cavity, or vacuole, into which the cell-protoplasm secretes digestive ferment and other chemical agents. Now there is no doubt

that such digestive vacuoles may burst and so pour out into the polyp's stomach a digestive juice which will act on food particles outside the substance of the cells, and thus by the substitution of this process of outpouring of the secretion for that of ingestion of food particles into the cells we get the usual form of digestion by juices secreted into a digestive cavity. Now this being certainly the case in regard to the history of the original phagocytes lining the polyp's gut, it does not seem at all unlikely, but on the contrary in a higher degree probable, that the phagocytes of the blood and tissues should behave in the same way and pour out sensitizers and opsonins to paralyze and prepare their bacterial food. And the experiments of Metchnikoff's pupils and followers show that this is undoubtedly the case. Whether there is any great variety of and difference between 'sensitizers' and 'opsonins' is a matter which is still the subject of active experiment. Metchnikoff's conclusion, as recently stated in regard to the whole progress of this subject, is that the phagocytes in our bodies should be stimulated in their activity in order successfully to fight the germs of infection. Alcohol, opium, and even quinine, hinder the phagocytic action; they should, therefore, be entirely eschewed or used only with great caution where their other and valuable properties are urgently needed. It appears that the injection of blood-serum into the tissues of animals causes an increase in the number and activity of the phagocytes, and thus an increase in their resistance towards pathogenic germs. Thus Durham (who was a pioneer in his observations on the curious phenomena of the 'agglutination' of blood-corpuscles in relation to disease) was led to suggest the injection of sera during surgical operations, and experiments recently quoted by Metchnikoff seem to show that the suggestion was well founded. After years of opposition bravely met in the pure scientific spirit of renewed experiment and demonstration, Metchnikoff is at last able to say that the foundation-stone of the hygiene of the tissues—the thesis that our phagocytes are our arms of defence against infective germs—has been generally accepted.

Another feature of the progress of our knowledge of disease—as a scientific problem—is the recent recognition that minute animal parasites of that low degree of unicellular structure to which the name 'protozoa' is given, are the causes of serious and ravaging diseases, and that the minute algoid plants, the bacteria, are not alone in possession of this field of activity. It was Laveran—a French medical man—who, just about twenty-five years ago, discovered the minute animal organism in the red blood-corpuscles, which is the cause of malaria. Year by year ever since our knowledge of this terrible little parasite has increased. We now know many similar to, but not identical with it, living in the blood of birds, reptiles and frogs.

It is the great merit of Major Ross, formerly of the Indian Army Medical Staff, to have discovered, by most patient and persevering experiment, that the malaria parasite passes a part of its life in the spot-winged gnat or mosquito (*Anopheles*), not, as he had at first supposed, in the common gnat or mosquito (*Culex*), and that if we can get rid of spot-winged mosquitoes or avoid their attentions, or even only prevent them from sucking the blood of malarial patients, we can lessen, or even abolish, malaria.

This great discovery was followed by another as to the production of the deadly 'Nagana' horse and cattle disease in South Africa by a screw-like, minute animal parasite, the *Trypanosoma Brucei*. The Tsetze fly, which was already known in some way to produce this disease, was found by

Colonel David Bruce to do so by conveying by its bite the Trypanosoma from wild big-game animals, to the domesticated horses and cattle of the colonists. The discovery of the parasite and its relation to the fly and the disease was as beautiful a piece of scientific investigation as biologists have ever seen. A curious and very important fact was discovered by Bruce—namely, that the native big game (zebras, antelopes, and probably buffaloes), are *tolerant* of the parasite. The Trypanosoma grows and multiplies in their blood, but does not kill them or even injure them. It is only the unaccustomed introduced animals from Europe which are poisoned by the chemical excreta of the Trypanosomes and die in consequence. Hence the wild creatures—brought into a condition of tolerance by natural selection and the dying out of those susceptible to the poison—form a sort of 'reservoir' of deadly Trypanosomes for the Tsetze flies to carry into the blood of new-comers. The same phenomenon of 'reservoir-hosts' (as I have elsewhere called them) has since been observed in the case of malaria; the children of the native blacks in Africa and in other malarious regions are *tolerant* of the malarial parasite, as many as 80 per cent. of children under ten being found to be infected, and yet not suffering from the poison. This is not the same thing as the immunity which consists in *repulsion* or *destruction* of the parasite.

The Trypanosomes have acquired a terrible notoriety within the last four years, since another species, also carried by a Tsetze fly of another species, has been discovered by Castellani in cases of sleeping sickness in Uganda, and demonstrated by Colonel Bruce to be the cause of that awful disease. More than 200,000 natives of Uganda have died from it within the last five years. It is incurable, and, sad to relate, not only a certain number of European employees have succumbed to it in tropical Africa, but a brave young officer of the Army Medical Corps, Lieutenant Tulloch, has died from the disease acquired by him in the course of an investigation of this disease and its possible cure, which he was carrying out, in association with other men of science, on the Victoria Nyanza Lake in Central Africa. Lieutenant Tulloch was sent out to this investigation by the Royal Society of London, and I will venture to ask you to join that body in sympathy for his friends, and admiration for him and the other courageous men who risk their lives in the endeavor to arrest disease.

Trypanosomes are now being recognized in the most diverse regions of the world as the cause of disease—new horse diseases in South America, in North Africa, in the Philippines and East India are all traced to peculiar species of Trypanosome. Other allied forms are responsible for Delhi-sore, and certain peculiar Indian fevers of man. A peculiar and ultra-minute parasite of the blood cells causes Texas fever, and various African fevers deadly to cattle. In all these cases, as also in that of plague, the knowledge of the carrier of the disease, often a mite or acarus—in that of plague the flea of the rat—is extremely important, as well as the knowledge of reservoir-hosts when such exist.

The zoologist thus comes into closer touch than ever with the profession of medicine, and the time has arrived when the professional students of disease fully admit that they must bring to their great and hopeful task of abolishing the diseases of man the fullest aid from every branch of biological science. I need not say how great is the contentment of those who have long worked at apparently useless branches of science, in the belief that all knowledge is good, to find that the science they have cultivated

has become suddenly and urgently of the highest practical value.

I have not time to do more than mention here the effort that is being made by combined international research and cooperation to push further our knowledge of phthisis and of cancer, with a view to their destruction. It is only since our last meeting at York that the parasite of phthisis or tubercle has been made known; we may hope that it will not be long before we have similar knowledge as to cancer. Only eighteen months have elapsed since Fritz Schaudinn discovered the long-sought parasitic germ of syphilis, the *Spirochæta pallida*. As I write these words the sad news of Schaudinn's death at the age of thirty-five comes to me from his family at Hamburg—an irreparable loss.

Let me finally state, in relation to this study of disease, what is the simple fact—namely, that if the people of Britain wish to make an end of infective and other diseases they must take every possible means to discover capable investigators, and employ them for this purpose. To do this, far more money is required than is at present spent in that direction. It is necessary, if we are to do our utmost, to spend a thousand pounds of public money on this task where we now spend one pound. It would be reasonable and wise to expend ten million pounds a year of our revenues on the investigation and attempt to destroy disease. Actually, what is so spent is a mere nothing, a few thousands a year. Meanwhile our people are dying by thousands of preventable disease.

Whilst I have been able, though in a very fragmentary and incomplete way, to indicate the satisfactory and, indeed, the wonderful progress of science since this association last met in York, so far as the making of new knowledge is concerned, I am sorry to say that there is by no means a corresponding 'advancement' of science in that signification of the word which implies the increase of the influence of science in the life of the community, the increase of the support given to it, and of the desire to aid in its progress, to discover and then to encourage and reward those who are specially fitted to increase scientific knowledge, and to bring it to bear so as to promote the welfare of the community. I am speaking on a privileged occasion to a body of men who are met together for the advancement of science, and I claim the right to say to them, without offence to the representatives of institutions which I criticize, what is in my mind.

It is, unfortunately, true that the successive political administrators of the affairs of this country, as well as the permanent officials, are altogether unaware to-day, as they were twenty-five years ago, of the vital importance of that knowledge which we call science, and of the urgent need for making use of it in a variety of public affairs. Whole departments of government in which scientific knowledge is the one thing needful are carried on by ministers, permanent secretaries, assistant secretaries and clerks who are wholly ignorant of science, and naturally enough dislike it since it can not be used by them, and is in many instances the condemnation of their official employment. Such officials are, of course, not to be blamed, but rather the general indifference of the public to the unreasonable way in which its interests are neglected.

A difficult feature in treating of this subject is that when one mentions the fact that ministers of state and the officials of the public service are not acquainted with science, and do not even profess to understand its results or their importance, one's statement of this very obvious and notorious fact is apt to be regarded as a personal offence. It is difficult to see wherein the

offence lies, for no one seeks to blame these officials for a condition of things which is traditional and frankly admitted.

This is really a very serious matter for the British Association for the Advancement of Science to consider and deal with. We represent a line of activity, a group of professions which are, in our opinion, of vital importance to the well-being of the nation. We know that those interests which we value so highly are not merely ignored and neglected, but are actually treated as of no account or as non-existent by the old-established class of politicians and administrators. It is not too much to say that there is a natural fear and dislike of scientific knowledge on the part of a large proportion of the persons who are devoid of it, and who would cease to hold, or never have held, the positions of authority or emolument which they now occupy, were scientific knowledge of the matters with which they undertake to deal required of them. This is a thorny subject, and one in which, however much one may endeavor to speak in general terms, it is difficult to avoid causing personal annoyance. Yet it seems to me one which, believing as I do that it is of most urgent importance, it is my duty as your president to press upon the attention of the members of the British Association. Probably an inquiry into and discussion of the neglect of science and the questionable treatment of scientific men by the administrative departments of government would be more appropriate to a committee appointed by the council of the association for this purpose than to the presidential address.

At the same time, I think the present occasion is one on which attention should be drawn in general terms to the fact that science is not gaining 'advancement' in public and official consideration and support. The reason is, I think, to be found in the defective education, both at school and university, of our governing class, as well as in a racial dislike among all classes to the establishment and support by public funds of posts which the average man may not expect to succeed by popular clamor or class privilege in gaining for himself—posts which must be held by men of special training and mental gifts. Whatever the reason for the neglect, the only remedy which we can possibly apply is that of improved education for the upper classes, and the continued effort to spread a knowledge of the results of science and a love for it amongst all members of the community. If members of the British Association took this matter seriously to heart they might do a great deal by insisting that their sons, and their daughters too, should have reasonable instruction in science both at school and college. They could, by their own initiative and example, do a good deal to put an end to the trifling with classical literature and the absorption in athletics which is considered by too many schoolmasters as that which the British parent desires as the education of his children.

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It is more agreeable to me not to dwell further on the comparative failure of science to gain increased influence and support in this country, but to mention to you some instances on the other side of the account. As long ago as 1842 the British Association took over and developed an observatory in the Deer Park at Kew, which was placed at the disposal of the association by Her Majesty the Queen. Until 1871 the association spent annually a large part of its income—as much in later years as £600 a year—in carrying on the work of the Kew Observatory, consisting of magnetic, meteorological and physical observations. In 1871 the association handed over the observatory to the Royal Society, which

had received an endowment of £10,000 from Mr. Gassiot for its maintenance, and had further devoted to that purpose considerable sums from its own donation fund and government grant. Further aid for it was also received from private sources. From this observatory at last has sprung, in the beginning of the present century, the National Physical Laboratory in Bushey Park, a fine and efficient scientific institution, built and supported by grants from the state, and managed by a committee of really devoted men of science who are largely representatives of the Royal Society. In addition to the value of the site and buildings occupied by the National Physical Laboratory, the government has contributed altogether £34,000 to the capital expenditure on new buildings, fittings and apparatus, and has further assigned a grant of £6,000 a year to the working of the laboratory. This institution all men of science are truly glad to have gained from the state, and they will remember with gratitude the statesmen—the late Marquis of Salisbury, the Right Hon. Arthur J. Balfour, Mr. Haldane and others—as well as their own leaders—Lord Rayleigh, Sir William Huggins and the active body of physicists in the Royal Society—who have carried this enterprise to completion. The British Association has every reason to be proud of its share in early days in nursing the germ at Kew which has at length expanded into this splendid national institution.

I may mention also another institution which, during the past quarter of a century, has come into existence and received, originally through the influence of the late Lord Playfair (one of the few men of science who have ever occupied the position of a minister of the crown), and later by the influence of the Right Hon. Joseph Chamberlain, a subsidy of £1,000 a year from the government and a contribution of £5,000 towards its initial expenses. This is the Marine Biological Association, which has a laboratory at Plymouth, and has lately expended a special annual grant, at the spontaneous invitation of His Majesty's Treasury, in conducting an investigation of the North Sea in accordance with an international scheme devised by a central committee of scientific experts. This scheme has for its purpose the gaining such knowledge of the North Sea and its inhabitants as shall be useful in dealing practically and by legislation with the great fisheries of that area. You will, perhaps, not be surprised to hear that there are persons in high positions who, though admittedly unacquainted with the scientific questions at issue or the proper manner of solving them, are discontented with the action of the government in entrusting the expenditure of public money to a body of scientific men who give their services, without reward or thanks, to carrying out the purposes of the international inquiry. Strange criticisms are offered by these malcontents in regard to the work done in the international exploration of the North Sea, and a desire is expressed to secure the money for expenditure by a less scientific agency. I do not hesitate to say here that the results obtained by the Marine Biological Association are of great value and interest, and, if properly continued and put to practical application, are likely to benefit very greatly the fishery industry; on the other hand, if the work is cut short or entrusted to incompetent hands it will no doubt be the case that what has already been done will lose its value—that is to say, will have been wasted. There is imminent danger of this perversion of the funds assigned to this scientific investigation taking place. There is no guarantee for the continuance of any funds or offices assigned to science in one generation by the officials of the next. The mastership of

the mint held by Isaac Newton, and finally by Thomas Graham, has been abolished and its salary appropriated by non-scientific officials. Only a few years ago it was with great difficulty that the government of the day was prevented from assigning the directorship of Kew Gardens to a young man of influence devoid of all knowledge of botany!

One of the most solid tests of the esteem and value attached to scientific progress by the community is the dedication of large sums of money to scientific purposes by its wealthier members. We know that in the United States such gifts are not infrequent; they are rare in this country. It is, therefore, with especial pleasure that I call your attention to a great gift to science in this country made only a few years ago. Lord Iveagh has endowed the Lister Institute, for researches in connection with the prevention of disease, with no less a sum than a quarter of a million pounds sterling. This is the largest gift ever made to science in this country, and will be productive of great benefit to humanity. The Lister Institute took its origin in the surplus of a fund raised by Sir James Whitehead when Lord Mayor, some sixteen years ago, for the purpose of making a gift to the Pasteur Institute in Paris, where many English patients had been treated, without charge, after being bitten by rabid dogs. Three thousand pounds was sent to M. Pasteur, and the surplus of a few hundred pounds was made the starting-point of a fund which grew, by one generous gift and another, until the Lister Institute on the Thames Embankment at Chelsea was set up on a site presented by that good and high-minded man, the late Duke of Westminster.

Many other noble gifts to scientific research have been made in this country during the period on which we are looking back. Let us be thankful for them, and admire the wise munificence of the donors. But none the less we must refuse to rely entirely on such liberality for the development of the army of science, which has to do battle for mankind against the obvious disabilities and sufferings which afflict us and can be removed by knowledge. The organization and finance of this army should be the care of the state.

It is a fact which many of us who have observed it regret very keenly, that there is to-day a less widespread interest than formerly in natural history and general science, outside the strictly professional arena of the school and university. The field naturalists among the squires and the country parsons seem nowadays not to be so numerous and active in their delightful pursuits as formerly, and the mechanics' institutes and lecture societies of the days of Lord Brougham have given place, to a very large extent, to musical performances, bioscopes and other entertainments, more diverting, but not really more capable of giving pleasure than those in which science was popularized. No doubt the organization and professional character of scientific work are to a large extent the cause of this falling-off in its attraction for amateurs. But perhaps that decadence is also due in some measure to the increased general demand for a kind of manufactured gaiety, readily sent out in these days of easy transport from the great centers of fashionable amusement to the provinces and rural districts.

In conclusion, I would say a word in reference to the associations of our place of meeting, the birthplace of our society. It seems to me not inappropriate that a society for the advancement of science should have taken its origin under the walls of York Minster, and that the clergy of the great cathedral should have stood by its cradle. It is not true that there is an essential antagonism between the scientific

spirit and what is called the religious sentiment. "Religion," said Bishop Creighton, "means the knowledge of our destiny and of the means of fulfilling it." We can say no more and no less of science. Men of science seek, in all reverence, to discover the Almighty, the Everlasting. They claim sympathy and friendship with those who, like themselves, have turned away from the more material struggles of human life, and have set their hearts and minds on the knowledge of the Eternal.

THE ITHACA MEETING OF THE AMERICAN CHEMICAL SOCIETY. II.

SECOND GENERAL SESSION.

At the second general session the following addresses were given:

Hydronitric Acid: L. M. Dennis.

Recent Progress in Industrial Chemistry: J. D. Pennock.

The address first cites the rapid progress of the ammonia soda process in comparison with the Le Blanc, showing that from 1870 to 1903 the world's production of soda by the ammonia process increased from 2,600 to 1,150,000 tons per annum, and the Le Blanc process decreased from 447,000 in 1870 to 150,000 in 1903. The reason for the continuance of industrial life in the Le Blanc works is the income obtained from bleaching powder and sulphur products. The progress of the electrolytic process is then discussed and a statement is made that in 1905 considerable profit was made by at least two concerns in England on the manufacture of electrolytic caustic soda and bleaching powder. Comment was made on the development of the treatment of fatty acids by carbonate of soda in the manufacture of soap, rather than the old method of treating neutral fats with caustic soda and thereby making a considerable saving. It was predicted that the tendency in industrial operations to the use of fuel gas from coke ovens and producers will ultimately do away with the smoke nuisance. The utilization of peat for producer gas and in the making of crude paper are interesting developments along this line. The introduction of alcohol free from tax after January 1, 1907, will call for a denaturizing substance of some sort. Doubtless the United States will follow the German practise of using a 2.5 per cent. solution made up of four liters of wood alcohol and one liter of pyridine added to 100 liters of alcohol. The future source of suitable nitrogen for the soil was then discussed. First dealing with Dr. Frank's calcium cyanimide process, then with Birkland and Eydes fixation of atmospheric nitrogen, and with the immediate and more practical application of ammonium sulphate manufactured on a large scale by the by-product coke ovens. It was predicted that in about thirty years the supply of nitrate of soda will be exhausted. The source of nitrogen must then be furnished by one of the above described processes.

Some Problems of Biological Chemistry: Waldemar Koch.

It was pointed out that it is possible to investigate a tissue from the point of view of a chemist without isolating definite chemical substances, by dividing the constituents into the following groups: proteids, carbohydrates, fats, lecithins, extractives, ash. These groups have a physiological significance and the distribution among them of definite substances or elements like phosphorus, which was especially discussed, can vary in some of these groups within wide limits under different physiological conditions. The possibility of determining the physiological value of the different combinations of phosphoric acid to the cell was illustrated by a number of examples.

INORGANIC CHEMISTRY.

L. M. Dennis, Chairman.

Some New Compounds of Thallium: L. F. HAWLEY.

Three new compounds of thallium were described: thallium fulminate, $Tl_2C_2N_2O_2$, thallium aluminate, $Tl_4Al_2O_5 . 2H_2O$, and potassium thallic chromate, $K_2CrO_4 . Tl_2(CrO_4)_3 . 4H_2O$.

Experiments upon the Radium Emanation: L. F. HAWLEY.

With the idea in view that the rare atmospheric gases might be the activizing agents of radioactive bodies an attempt was made to find whether the atmosphere produced any effect on the emanations from radium. A water solution of radium chloride was kept in an atmosphere of hydrogen entirely free from the atmospheric gases, and the emanations produced during several three-day periods were measured by bubbling the pure hydrogen through the solution and leading the hydrogen and emanation into a measuring tube connected with an electrometer. Then similar measurements were made under exactly the same conditions except that air was used in the place of the hydrogen. No difference was found except that due to the difference in the absorption of the radiations by the hydrogen and the air.

On the Reaction between Hydrazine Sulphate and Potassium Chlorate: A. W. BROWNE.

This reaction does not proceed in presence of sulphuric acid entirely in accordance with the general equation for the oxidation of hydrazine sulphate as given by Roberto and Roncali:

$$N_2H_4 . H_2SO_4 + 2O = N_2 + 2H_2O + H_2SO_4.$$

Three series of experiments have been made, from which it is evident that the reaction takes place very largely as expressed by the following equation:

$$4N_2H_4 . H_2SO_4 + 4O = 2HN_3 + (NH_4)_2SO_4 + 3H_2SO_4 + 4H_2O.$$

Within certain limits the yield of HN_3 varies directly with the amount of H_2SO_4 present and inversely with the excess of $KClO_3$. Under favorable conditions the yield amounts to over 23 per cent. of theory according to the above equation.

A Modified Hydrogen Sulphide Generator: A. W. BROWNE and M. F. MEHLING.

The apparatus is essentially a modified Ostwald gas generator capable of furnishing hydrogen sulphide in quantities sufficient to supply a class of 275 students. The supply of acid (1:1 HCl) and the discharge of the thoroughly neutralized spent acid is automatically regulated by a method somewhat similar in principle to that employed in the Parsons apparatus.

On the Analysis of Silver Trinitride: L. M. DENNIS and A. W. BROWNE. (By title.)

Colorimetric Determination of Iron with special reference to Purity of Reagents: H. N. STOKES and J. R. CAIN.

The interfering action of large amounts of acids or salts is avoided by concentrating the iron, either by evaporation in the case of easily volatile substances or by carrying down as hydroxide by manganese dioxide (reduced from permanganate) or as sulphide by cadmium sulphide. After suitable treatment it is dissolved in free sulphocyanic acid saturated with mercuric sulphocyanate, and after adding a little persulphate is extracted with amyl alcohol in the colorimeter cylinder, the duplicate cylinder containing the same volume of sulphocyanic acid and amyl alcohol. Less than 0.001 mg. iron may thus be detected in 50 grams of a non-volatile salt.

Beryllium Carbonate: CHARLES L. PARSONS and EDWIN J. ROBERTS.

Normal beryllium carbonate can not be

made at ordinary pressures in contact with water. $BeCO_4 + 4HO$ described by Klatzo does not exist, and attempts to make it by his method yield only slightly carbonated hydroxide. Basic beryllium carbonate appears to have no definite composition and can be almost completely converted into the hydroxide by boiling in water. All attempts to increase the proportion of the CO_2 components over the proportion $2Be(OH)_2 . BeCO_3$ failed, although CO_2 was passed for three months through the basic carbonate under slightly increased pressure. The basic carbonates described in literature must have contained at least one or two per cent. of the carbonate used as a solvent or precipitant.

The Separation and Estimation of Beryllium: Chas. L. Parsons and Stuart R. Barnes.

Beryllium is separated from aluminum and iron by the complete solubility of its hydroxide in a hot saturated solution of acid sodium carbonate—ferric hydroxide and aluminum hydroxide being completely insoluble. Double precipitation is essential. Beryllium hydroxide must be washed with water containing an electrolyte in solution, for when pure it rapidly washes through the filter in a colloidal condition. Sodium acetate used in this manner gave excellent results.

The Elementary Nature of Tellurium: J. F. Norris.

On account of the fact that the atomic weight of tellurium is inconsistent with its position in the family which contains sulphur and selenium in the periodic classification of the elements, the author undertook a series of experiments to determine whether tellurium contains an undiscovered element. In order to free the tellurium from any element which does not belong to the sulphur family, it was converted into the compound $Na_2S_4TeO_6$, and from this derivative of sodium pentathionate, the tellurium was separated. In order to determine whether the element contained another element in the sulphur family, with an atomic weight higher than that of tellurium, a sample of carefully purified telturium dioxide was subjected to fractional sublimation. Atomic weight determinations were made of the element in the various fractions as well as of that in the unsublimed oxide and of the tellurium prepared from the derivative of the sodium pentathionate. The result was the same in all cases, namely, 127.6. The work establishes more definitely than has been done heretofore the elementary nature of tellurium.

On the Mercuri-ammonium Salts and Bases: E. C. Franklin.

It will be shown in this paper that the so-called mercuri-ammonium salts are not substituted ammonium salts at all, but are to be classified under the three heads as (1) mercury salts with ammonia of crystallization, (2) ammoni-basic mercuric salts, and (3) mixed hydro-basic ammono-basic mercuric salts. For example, the fusible white precipitate is mercuric chloride with ammonia of crystallization, $HgCl_2 . 2NH_3$, and not mercuri-diammonium chloride, $Hg(NH_3)_2Cl_2$, the infusible white precipitate is ammono-basic mercuric chloride, NH_2HgCl, a compound related to ammonia as the ordinary basic salts are related to water and is not mercuri-ammonium chloride, $HgNH_2Cl$, while the chloride of Millon's base is a salt basic both to ammonia and water and is not oxydimercuri-ammonium chloride nor yet a hydrated dimercuri-ammonium chloride.

Potassium Ammono-zincate: E. C. Franklin and F. F. Fitzgerald.

Recalling the analogy between liquid ammonia and water as electrolytic solvents as emphasized in earlier papers by Frank-

lin and his co-workers, the authors have shown that potassium amide acts upon metallic zinc and upon zinc amide in liquid ammonia in a manner analogous to the well-known action of potassium hydroxide on metallic zinc and zinc hydroxide in aqueous solution. The ammono-potassium zincate, $Zn(NHK)_2$, analogous to the oxygen compound formed in aqueous solution, has been prepared. Other compounds belonging to this class undoubtedly exist, but have not yet been satisfactorily isolated.

Liquid Methylamine as a Solvent: H. D. GIBBS.

A consideration of the many analogies between water and liquid ammonia as electrolytic solvents has led to a study of methylamine which, formally related to ammonia as methyl alcohol is related to water, might be expected to exhibit interesting properties. It has been found to possess very wide solvent power; it unites with many inorganic salts and organic compounds as methylamine of crystallization, and it gives solutions with certain salts which exhibit unique conductivity curves.

Hydronitric Acid: L. M. DENNIS and HELEN ISHAM.

Anhydrous hydronitric (HN_3) was prepared by treating crystalline KN_3 with sulphuric acid (2:1). The dried gas was solidified by means of liquid air. Its melting-point is $-80°$. The boiling-point of the liquefied acid is 37°. The determination of the vapor density by the Victor Meyer method showed that at a temperature about 25° above its boiling-point the acid possesses the molecular formula HN_3. Several new salts of the acid were prepared and studied. The reaction between dry hydronitric acid and dry hydrochloric acid was carefully examined and found to proceed according to the equation

$$3HN_3 + HCl = NH_4Cl + 4N_2.$$

INDUSTRIAL CHEMISTRY.

J. D. Pennock, Chairman.

Notes on the Use of Peat: CULLEN W. PARMELEE.

A restatement of some phases of the peat industry of especial interest to the agricultural chemist with particular reference to the use of it as a filler in fertilizers. The average nitrogen of 123 samples of New Jersey peats analyzed in the writer's laboratory is reported as 1.75 per cent.

A Review of the American Cement Manufacture: R. K. MEADE.

Experiments made at Sault Ste. Marie, Ont., under the Auspices of the Canadian Government, in the Smelting of Iron Ores by the Electrothermic Process: Dr. EUGENE HAANEL.

In this paper Dr. Haanel points out the importance of the electric smelting process, especially for countries possessing water-powers and ore deposits, but lacking coal for metallurgical use, and gives a description of the plant erected and experiments conducted at Sault Ste. Marie, with a view of ascertaining several important items, which could not be obtained by the commission previously appointed by the Canadian government. (The report of this commission was published in 1904 by the Mines Branch of the Interior Department, Ottawa.)

The following is a summary of the results of the experiments: (1) Magnetite can be as economically smelted by the electro-thermic process as hematite. (2) Ores of comparatively high sulphur content can be made into pig iron containing only a few thousandths of a per cent. of sulphur. (3) The silicon content can be varied as required for the class of pig to be produced. (4) Charcoal which can be cheaply produced from mill refuse or wood which could not otherwise be utilized and peat-coke can be substituted for coke as re-

ducing agent. (5) A ferro-nickel pig can be produced practically free from sulphur from roasted nickeliferous pyrrhotite. (6) Titaniferous iron ores containing up to 5 per cent. of titanic acid can be successfully treated. (7) Under normal conditions an expenditure of 1,000 E.H.P. days is required for an output of twelve tons of pig iron.

Classification of Coals: S. W. Parr.

The classification proposes to proceed on the basis of the old nomenclature offered by Frazier, but it bases the distinctions upon data of a different sort. The main divisions in the classification are made to depend upon the ratio of the volatile carbon to the total carbon, and by volatile carbon is meant not the volatile matter as that term is sometimes erroneously applied, but the carbon part of the hydrocarbon constituents as indicated by the difference between total carbon and fixed carbon. This leads directly to a further factor, namely, that part of volatile matter which is inert and non-combustible, and this constituent is made to indicate the further subdivision in the bituminous coals proper, and between the bituminous coals and the lignites, as well as between the different forms of lignites themselves. The method of classification was illustrated by making use of the complete analytical results from over one hundred samples of coal selected from representative fields throughout the United States.

Salt in the State of New York, its History, Resources and Manufacture: F. E. Engelhardt.

The presence of salt in the state of New York is first recorded in the so-called 'Relations of the Jesuit Fathers,' by Father Jerome Lallemant and Father Charlevoix, 1645–6. First salt made by Father Simon LeMoyne in August, 1653. Practical manufacture of salt begun at Syracuse in 1788. The Indians ceded to the state of New York their land in the treaty at Fort Schuyler, 1788, except the lake and the lands for one mile round it, and in the treaty at Cayuga Ferry, 1795, they ceded this and a strip one half mile wide on the west side of Onondaga Creek from their village to the lake, about six miles long. The legislature of the state passed its first law regulating the manufacture of salt in 1797.

The manufacture of solar salt was begun in 1821, and in the same year Major B. Boyington sunk a well 300 feet deep for rock salt, without results. Wells were first square holes, about 30 feet deep by 20 feet wide, followed by cast-iron tubing of 8-inch bore; next came wooden tubing, and for the last fifty years wells have been tubed with 6- and 8-inch wrought-iron pipes. Wood was first employed as fuel, then semi-bituminous coal, and lately anthracite coal-dust with artificial draft. About 50 bushels of salt (of 56 pounds each) is the average result with good dust and brine of 68 salometer at 60° F. Largest amount of salt was produced in 1862, namely, 9,053,874 bushels. Total production up to date at Syracuse, about 433 million bushels, or over 12 million tons.

Salt is made in the state by artificial means, as in the kettle or Onondaga method, at Syracuse. In the western part of the state salt is made in the open pan, in grainers (the Michigan system) and in the vacuum pan. By solar heat in shallow wooden vats with movable wooden covers to protect them against rain. Their capacity is greatly increased by the so-called 'salt aprons.' This method is only practised at Syracuse. The total salt production of the state amounted, in 1905, to about 5,435,005 barrels of 280 pounds, or 5 bushels, each.

Rock salt was first discovered on June 20, 1878, in Wyoming County, on the farm

of Mr. Matthews, at a depth of 1,270 feet. The bed was 70 feet in thickness. The first shaft for mining the rock salt was finished in 1885. It is situated near Piffard, Livingston County, and is 1,018 feet deep. It is called the Retsof shaft. The Greigsville shaft is about one mile south of the former. The third shaft is two miles south of LeRoy and has a depth of 825 feet, and the fourth shaft was sunk at Livonia, Livingston County, to a depth of 1,430 feet. But one mine, the 'Retsof,' is at present operated.

All the salt wells of the state without exception, as well as these four salt shafts, obtain their brine or salt from one and the same rock-salt deposit, situated in the 'Upper Silurian.' It extends from Morrisville, Madison County, to Lake Erie, and from LeRoy to Watkins. The salt stratum is over 100 feet in thickness, depending entirely upon the configuration of the ground below the Silurian sea at the time of its formation. The rock salt occurs in one vein, two, three, four, five, six or even seven veins of various thickness and depth from the surface of the ground. The dip of the rock is southwest, about 41 to 46 feet.

The Solvay Process Company, after three attempts, finally obtained rock salt almost directly under the Tully Hills, which are 300 feet above, and has at present 51 wells, 30 on the east side, and 21 on the west side, of the Onondaga Valley, which at the present time supplies them with the brine required for the manufacture of soda ash, caustic soda, baking soda, etc.

Sources of Some Common Impurities in C. P. Chemicals: JAMES W. SCHADE.

The object of this paper is to present the sources of impurities in chemical reagents and to show that there are limits to the purity obtainable by manufacturers. The sources of impurities are: (1) the containers in which chemicals are shipped; (2) tanks, stills, condensers, and so on, in which chemicals are made; (3) reagents used to precipitate certain impurities or compounds formed by these reactions; (4) minerals from which the chemicals are made and materials used in manufacture. The danger of contamination by impurities of the first two classes may be minimized by careful selection of material for containers and apparatus. The presence of both barium and sulphate in a sample of sodium chloride and of calcium in ammonium oxalate are examples of impurities of the third class. Impurities of the fourth class are illustrated by the persistence of calcium in barium compounds and the constant association of nickel and cobalt in their purified salts. For ordinary work, however, reagents that will give accurate results can be manufactured at a reasonable cost.

On the Determination of Carbon Disulphide and Total Sulphur in Commercial Benzol: EDWARD S. JOHNSON.

(1) *The Determination of Carbon Disulphide.*—The principle underlying the method seemingly most widely applied is that of the transformation of carbon disulphide by means of alcoholic potash[1] into potassium xanthate, utilizing this substance as a medium for separation. For determination the potassium compound is best converted into cuprous xanthate and the latter into CuO. Much uncertainty exists apparently as to the exact composition of the so-called cuprous xanthate. If constituted as represented by the formula $(CS.OC_2H_5S)_2Cu_2$, the ratio of CuO produced to CS_2 entering into the formation of the xanthate should be 1.0:0.9563. Macagno[2] found 1.0:1.931, a little more than *twice* the theoretical. Others have obtained similar results. As evidently cuprous xanthate is not the compound under consideration, an investigation seemed

[1] Nickels, *Chem. News*, 43, 148.

[2] *Chem. News*, 43, 138.

desirable, and the more so because of a strong probability of a variation in composition with changing conditions of formation. Experiments were, therefore, made, operating with known quantities of carbon disulphide dissolved in pure benzol, to ascertain the desired *ratio under given, easily-realized conditions.* An average of 1.0:1.750 was found. The factors most strongly influencing the ratio, as far as studied, are size of the xanthate precipitate (the CS_2 present) and the time of its exposure to the mother liquors. By adhering to definite conditions very satisfactory analytical results are obtainable.

(2) *Determination of Total Sulphur in Benzol.*—The determination is accomplished by volatilization of the sample in a current of hydrogen and combustion of the vapors in an atmosphere of oxygen. The products of combustion are passed into a suitable absorption medium and the sulphur determined by familiar methods. A new *form of apparatus* for the combustion is described. The essential feature is the vertical combustion tube, 35 mm. in diameter and 170 mm. long. This is supplied with oxygen at the upper end, the products of combustion leaving at the bottom. The vapors are admitted by the burner-tube inserted through a horizontal arm in the center of the tube. Diametrically opposite is a similar arm carrying a pilot-flame tube. The flame, of hydrogen, is placed close to the burner-tip and serves to ignite the vapors at once upon their arrival, and further permits, evidently, the reestablishment of the combustion should it be accidentally or necessarily interrupted for a few moments. About 5 grams of benzol may be burned in three hours. Entirely satisfactory determinations were found possible. Samples with as much as 5 per cent. CS_2, and doubtless more, are readily handled with success. Insuring perfect and convenient combustion, the apparatus could be extended in its application to gases and vapors of whatever description. Fuel and illuminating gases are here in mind. It could further doubtless be made to lend itself in many instances advantageously to sulphur determinations in the ultimate analysis of organic compounds.

The Technical Determination of Benzol in Illuminating Gas: D. A. Morton.

Examination of the method of Dennis and O'Neill for the determination of benzene in illuminating gas (*Jour. Amer. Chem. Soc.*, 1903, p. 503) shows that the results are low, and unless the reagent be freshly prepared for each test, not even approximately correct. Moreover, the absorbent (ammonium nickel nitrate solution) dissolves benzene only to the same extent as pure water, showing that the presence of nickel compound has no influence. As a practical method for the determination of benzol in coal gases, absorption by means of concentrated sulphuric acid is recommended. By the use of this reagent a good separation of benzol from ethylene is effected.

BIOLOGICAL CHEMISTRY.

Waldemar Koch, Chairman.

The Phosphorous Content of Feces Fat: J. H. Long.

It is stated in many works on physiological chemistry that lecithins and similar bodies are either absent or present only in traces in the fat extracted from feces. In a previous paper the author pointed out that an organic phosphorous compound of the lecithin type may be sometimes present in relatively large amounts. In the present paper the results are given of the analyses of feces fat from seven individuals in which the phosphorous content was found to vary within wide limits. This phosphorus was in organic combination and apparently in a

body of the lecithin type. Some statements are made of the possible sources of the lecithins in feces.

Dissociable Compounds of Mucoids and other Proteins: W. J. GIES.

We know practically nothing about the ways in which proteins are held in living protoplasmic structures. The molecules of the protein compounds are relatively so large that as yet our physico-chemical methods of measurement are inadequate to give us correct ideas of molecular size and intramolecular structure, although we know much about the lifeless and, in some respects, comparatively meaningless fragments into which protein molecules may be broken. Our ignorance of the fundamental biochemical relation of proteins to the associated constituents of protoplasm appears to be largely due to our vague knowledge of the chemical statics and dynamics of true cellular proteins, a fact which serves, however, as a constant stimulus to protein investigation. Among the many protein substances, the nucleoproteins and the glucoproteins are very important tissue constituents. The essential part of each of these natural type proteins and the part to which the usual name is applied appears to be a colloidal organic acid. The forms in which the acid radicals occur in cells and tissues have not been definitely made out, although it is natural to presume that the acid radicals are united directly to one or more distinctly basic radicals in each case, and that variations in the characters of such compounds are associated with physiological as well as pathological variations of cellular composition and tissue function. The author has attempted to get to the bottom of this complicated matter by making definite salts of these proteins with the aid of methods that could be relied upon to leave the acid radicals unchanged.

The writer has lately prepared calcium, sodium, potassium and ammonium salts of mucoid by the following process: The slightly alkaline solution of glucoprotein is dialyzed until neutral and then poured into a large excess of 95 per cent. alcohol, which causes the precipitation of the mucoid. This precipitate is purified by resolution, dialysis and reprecipitation. The final product is made anhydrous by treatment with absolute alcohol and ether. The comparatively pure salts thus obtained are light snow-white powders.

The author hopes that, by increasing the knowledge of artificial products, analogies with natural compounds would be not only more easily recognized but also the characters of functions of the compounds in living protoplasm would be more thoroughly understood.

G. R. WHITE,
Press Secretary.

SCIENTIFIC BOOKS.

Leitfaden für den praktisch-chemischen Unterricht der Mediziner. Zusammengestellt von FRANZ HOFMEISTER, Professor der physiologischen Chemie an der Universität Strassburg. II. Aufl. Braunschweig, Viewig u. Sohn. 1906. Pp. 136. Preis Mark 3.50.

This little book admirably describes laboratory courses in qualitative analysis, organic chemistry (so far as it may be of interest to the physician) and in physiological chemistry. The directions given for making tests are brief and precise and at many places reasons are given for the methods advised in making the tests. In this revision it appears that particular attention was given to the course in physiological chemistry so that it might include the results of the latest investigations bearing especially upon the tests for the substances concerned in that branch of science. In short, the book is one which excellently covers the ground in practical chemistry essential to medical students.

JOHN MARSHALL.

SCIENTIFIC JOURNALS AND ARTICLES.

The leading article in the August number of the *Journal of Nervous and Mental Disease* is Dr. Stedman's address as president of the American Neurological Association. His subject was 'The Public Obligations of the Neurologist,' and he urged the establishment of charitable sanitaria for the care of the poor who suffered from nervous diseases. He spoke of the fading out of the division between psychiatry and neurology, and the advance of the treatment of mental disorders by mental and moral methods. He also emphasized the importance of public provision for the after care of patients discharged from the state hospitals, and urged the removal of the feeble-minded to separate colonies. Drs. Spiller and Weisenburg contribute the report of eleven cases of carcinoma involving the nervous system, with a number of illustrations. Dr. Burr follows with a note on the temporary disappearance of the sensory symptoms in syringomyelia, and Dr. Martin adds a short study of the sphincter reflexes in tabes dorsalis and paresis.

The *Annals of Iowa* for July, 1906, a magazine published quarterly by the State Historical Department at Des Moines, contains an appreciative biographical memoir of the late Dr. C. C. Parry, by Dr. Charles A. White. This memoir thus becomes a part of the state archives.

DISCUSSION AND CORRESPONDENCE.

THE PRIMARY SEPTA IN RUGOSE CORALS.

In Science, June 30, 1905, there appears an abstract of a paper, 'Early Stages of some Paleozoic Corals,' read by Mr. C. E. Gordon before the New York Academy of Sciences. The abstract is mainly a criticism of my paper, 'Relationships of the Rugosa (Tetracoralla) to the living Zoantheæ,' 1902. Having delayed a reply until the publication of the complete contribution,[1] I am now in a better position to estimate the value of the evidence upon which the author's assertions are based. A full discussion, with additional evidence in support of my contentions, will appear later, but in the meantime the importance of the subject calls for a brief statement.

The greater part of Gordon's final paper is devoted to a demonstration that the septal arrangement in *Lophophyllum proliferum*, the form studied by me, can be brought into agreement with the usually accepted septal plan of zaphrentoid corals, a fact upon which there could possibly be no divergence of opinion. To accomplish this he reproduces most of my figures, but in an inverted manner, and then shows how they agree with the septal plan of a zaphrentoid coral as represented by a schematic figure taken from Kunth, 1869–70. In the course of this Gordon corrects a confusion of mine, corrected elsewhere, in which I transpose the terms cardinal and counter septa; apparently, however, he does not realize the difference in the septal plan as established from the external ridges and grooves and that from the disposition of the septa within the calice.

In inverting my figures Gordon is altogether at variance with every recent worker on the Zoantharia. The dorso-ventral disposition of Kunth's schematic figure was given before much was known of the morphology and relationships of the Zoantharia. It would have been much easier and displayed a wider appreciation of recent work on the subject if Gordon had inverted his own figure and allowed the others to retain the orientation originally given them.

The main contention of the paper centers in the number of primary septa (protosepta) in the Rugosa, whether four or six. The great importance for phylogenetic purposes of a correct determination of this demands that Gordon's remarks and evidence should be submitted to thorough analysis. In my paper on *Lophophyllum proliferum* I showed that this species has six primary septa, thereby confirming the account of Pourtalès in 'Deep Sea Corals.' Gordon does not question this hexamerism, but attempts to explain it as a case of acceleration; according to his idea four primary septa were originally present, but the time of appearance of a third pair has been hastened so as to give six primary septa. No facts nor valid arguments are adduced in

[1] *Amer. Jour. Science*, February, 1906.

support of this purely hypothetical acceleration; much is made of a suggestion that acceleration is likely to occur because *Lophophyllum* appears late (Carboniferous) in the geological history of the Rugosa. The author then produces what he considers evidence in favor of a primary tetrameral plan. This rests entirely upon a decalcified silicified specimen of *Streptelasma profundum* (Owen) in which no doubt was left in the author's mind that four of the strongest septa extended farthest down into the base of the calice. No sections are given, and no other suitable material seems to have been at command.

I, likewise, have in my possession numerous decalcified silicified specimens of *S. profundum*, the septal plan of one of which is figured in *Biol. Bull.*, June, 1905, p. 39. Some of these are beautifully perfect, and present all the appearances described by Gordon, but one would scarcely think of using mere surface views for the determination of a question of such fundamental importance, especially when more reliable means are available. Since the publication of my paper in 1902 I have made special efforts, with the assistance of grants from the Carnegie Institution, to secure from all parts typical species of the Rugosa with perfect tips suitable for the investigation of this particular problem. Any one familiar with the subject knows how very rare such specimens are and the difficulties which surround their examination. From my study of these, by the method of grinding, I can now state that *in five different species I have definitely determined the presence of six primary septa*, all equal, and situated at equal distances apart. These species are *Streptelasma rectum* Hall, already figured in *Biol. Bull.*, June, 1905, *Cyathaxonia cynodon* E. & H., *Hadrophyllum glans* (White), *Hadrophyllum pauciradiatum* E. & H., and *Microcyclus discus* Meek & Worthen. Many other species have been investigated, but for one reason or another their tips were unfavorable for showing the primary septa, yet in tracing the development of the later septa this so closely agreed with the species mentioned that there can be no reasonable hesitation in assuming that their primary septa were hexameral. In no instance were there only four protosepta.

Thus, with the addition of *Lophophyllum proliferum*, the hexamerism of which Gordon does not dispute, there are now six known species of Rugosa each having six primary septa, while not a single undoubted instance of only four primary septa has been brought forward. Moreover, the geological distribution of the species mentioned is so wide, from the earliest to the latest appearance of the Rugosa, that Gordon's main argument in favor of acceleration fails in its application. Unless, therefore, fresh and weighty evidence to the contrary should be forthcoming we are reasonably justified in considering the primary hexamerism of the Rugosa as established.

The underlying significance of the primary hexamerism of the Rugosa is that it admits of the relationship of the group with other Anthozoa being established. In the past the assumed tetramerism has led to many fanciful suggestions. In my original paper I showed conclusively that the Rugosa find their nearest modern relatives among the zoanthid actinians, and subsequent work, especially on the fossula, has but served to confirm this. Unless Gordon can produce more acceptable evidence than is contained in his paper under review his contribution must be regarded as a retrograde step in our efforts to determine the phylogenetic relationships of the Rugosa.

J. E. DUERDEN.

RHODES UNIVERSITY COLLEGE,
GRAHAMSTOWN, CAPE COLONY.

THE SOURCE OF THE ENERGY OF CYCLONES.

TO THE EDITOR OF SCIENCE: In the issue of SCIENCE of May 5 last you were good enough to publish a communication of mine suggesting the source of origin of cyclones, cold waves, and tornadoes. Since the appearance of that article there has occurred to me the suggestion of the derivation of the energy involved in the movement of these bodies, or I might better say, a mechanism of the action of the prevailing westerly winds in accomplishing their movement, that has not hitherto been suggested by any one, as far as I know.

When a cyclone has once been inaugurated, in whatever way this may be effected, it presents itself as a mountain of air with a tendency to rise to a great height into the prevailing over-current. If established before starting on its journey, there was an inrush of air from every direction, and to the extent of the momentum of this inrush the mountain was a hollow one and its area a 'low.' At a variable distance above the earth's surface the crest of the cyclone is struck and carried away forward by the prevailing over-current, which in the tropics is the returning-loop of the uplifted trades as they journey west, after that this same loop becoming the antitrade as it takes a brief turn poleward, and finally the prevailing westerlies in the temperate regions.

Now it is well known that the prevailing westerlies, or any other steady winds blowing across a mountain chain, draw up the air on the leeward side of the mountain, condensing its moisture into a constant cloud. There is also a well-known instrument now widely used by surgeons and painters, which consists of a tube opening at right angles to the mouth of another tube which dips into the fluid to be sprayed. By blowing through the first tube a liquid is made to rise up through the second or perpendicular one. In both these instances the horizontal current, by the momentum of its trajectory, has to a greater or less extent removed the pressure of the superincumbent atmosphere and permitted the surrounding pressure to force the air or the liquid upward.

Now in the case of the beheading of our cyclonic mountain, the available energy is the momentum of the horizontal trajectory of the upper prevailing winds. Twenty-seven inches of mercury is probably the extreme of 'low' for any cyclone, and this shading off to zero at the edges, so that an average fall of one inch over the entire area of a cyclone is the highest probably ever attained if, indeed, it goes nearly so high. This prevailing wind is operative at from 2,000 feet to ten or more miles high, while moving at a speed of from, say, 50 to 250 miles an hour. But, whether it embraces the entire operative force or not, this prevailing overcurrent supplies a vast amount of the energy of motion to cyclones and is to that extent a *vera causa*. Again, the translatory energy, as well as the gyratory, may be derived from the same source. While the crest of the cyclonic mountain is being dragged away forward, the body of the cyclone itself is made to lean in the same direction. In this case air, drawn into the cyclone from in front, reaches its body at a given height in less time than a like mass drawn in from the rear, and this still more when the cyclone is in motion. The result altogether will be that the diameter of the base of the cyclone is added to more rapidly in front than in the rear. This of necessity results in a forward movement of the center of gravity; and, since the cyclone is rotating, it must continuously advance in order to make its axis correspond with its center of gravity. Indeed, so much is this the case that the axis of a cyclone is probably curved—advanced at the base and at the top while lagging in the middle.

D. T. Smith.

SPECIAL ARTICLES.

RECENT DISCOVERIES OF QUATERNARY MAMMALS IN SOUTHERN CALIFORNIA.

Several months ago Mr. F. M. Anderson called my attention to a deposit of bones occurring in asphalt beds near Rosemary Station about nine miles west of Los Angeles. In a small collection of specimens kindly presented to me by Mr. Anderson there were represented a number of Quaternary mammalian species which are either new to the fauna of the Californian region or have been very imperfectly known.

Recently Mrs. Ida Hancock, the owner of the property on which the asphalt deposits are located, has very kindly given to the University of California permission to carry on excavation work in these beds, and a considerable collection of valuable material has been obtained.

The beds in which the bones occur extend over many acres. So far as I am aware the bottom has not been reached in excavations carried to the depth of at least fifteen feet in quarrying the asphalt. Bones are scattered

through a large part of the deposit, but are very unevenly distributed. In some localities they are present in large numbers and in fairly defined layers.

The asphalt has in many cases penetrated even the minute pores of the bone, but the original material of the skeleton is practically unchanged.

The remains recognized up to the present time include the following forms: *Elephas, Equus, Bison,* a mylodont, *Smilodon, Canis indianensis* (?), *Canis* (small species), and camel remains. Numerous bird bones and remains of insects are also found.

In a considerable number of cases large parts of skeletons are found together, showing that the carcasses were entombed so quickly that there was not sufficient time for decomposition to permit separation of the parts.

Of the specimens obtained up to the present time an extraordinarily large percentage represent carnivora. The number of carnivores is certainly relatively larger than the usual percentage in a well-balanced fauna, and this abundance must be attributed to peculiar conditions under which the bones accumulated. Undoubtedly most of the remains are those of animals that have been entrapped or mired in the asphalt at times when it formed a deposit around tar springs. The surface of the asphalt is very sticky in some places at the present time, and where cuts are opened in it tar may ooze out. Such pools have probably existed here interruptedly through a long period, and particularly during Quaternary time when the deposit was forming. Carnivores are numerous because they were attracted by birds and mammals caught in the asphalt. Perhaps it is not entirely a coincidence that the carnivore remains are usually associated with those of birds or mammals, which would be their natural prey. The considerable number of young sabre-tooth cats present may indicate that the younger and less experienced individuals were more easily lured into the tar pools.

During the first examination of the beds several small, pebble-like bones were obtained which resembled the dermal ossicles of the ground-sloth, *Grypotherium,* recently described by Dr. A. Smith Woodward[1] from skin fragments obtained in a cave at Last Hope Inlet, Patagonia. The ossicles were in association with remains of a large ground-sloth somewhat similar to *Mylodon* in foot structure. Realizing that the peculiar conditions of accumulation offered an especially favorable opportunity for preservation of the dermal armor of a ground-sloth, during the second study of the deposits an attempt was made to find a specimen in which the armor might be recognized. Several hundred yards from the location of the first specimen, a large scapula resembling that of a mylodont was found partly exposed, with a row of small ossicles immediately over the outer side. The section of the bed containing these bones has recently been worked out, and the row of small bones proves to be the edge of a distinct layer including between 250 and 300 individuals. They mantle over the outer surface of the scapula, being removed from it by about an inch of asphalt.

The layer of bones as we find it has probably been disturbed somewhat and does not occupy its original position exactly, but the fact that it remains as a distinct layer with a tendency toward similar orientation of the individual ossicles indicates that the disturbance has not been great. As the position of the layer in the asphalt was nearly vertical, the presence of the large number of ossicles together may not be attributed to the washing together of scattered elements on the floor of a small basin of deposition.

The ossicles are not closely pressed together and are not superimposed. The individuals range in size from a cross-section of 6.5 x 4.5 mm. to 21 x 16 mm. Excepting a few of the largest ones, which are nearly square, the greater number are rounded and rather irregular in form. The outer side is in some cases more regularly modeled than the inner. The surface of the bones is somewhat roughened or pitted in some instances, but no markings are present which would be considered as definite

[1] A. Smith Woodward with Dr. F. P. Moreno, *Proc. Zool. Soc. Lond.*, 1899, pp. 144–156, pls. 13–15; also A. Smith Woodward, *Proc. Zool. Soc. Lond.*, 1900, pp. 64–79, pls. 5–9.

sculpturing. The microscopic structure has not yet been examined.

In general the form, size and arrangement of the ossicles are much as in the bones in the *Grypotherium* skin from Patagonia. The skin fragment first described by Woodward was thought to represent mainly the region of the neck and shoulder. The Californian specimen mantles over the outer side of the scapula, and is presumably not far removed from its original position with relation to this bone. The generic position of the form represented by this specimen appears as yet somewhat uncertain, but a satisfactory determination of its affinities will probably be possible when the skeletal material available has been finally assembled.

John C. Merriam.

A SUGGESTION FOR INTENSIFYING THE DÖPPLER EFFECT.

It has never been pointed out, I believe, that the relation between the conjugate foci of a concave mirror furnishes, at least in theory, a means of enormously intensifying the Döppler effect. If we have a source of light a little outside the principal focus of a concave mirror we shall have an inverted image formed at a considerable distance; and if the source move toward or from the mirror the image will move in the opposite direction with a much greater speed.

Let f_1 and f_2 be any two conjugate focal distances, and F the principal focal distance; then

$$\frac{I}{f_1} + \frac{I}{f_2} = \frac{I}{F}$$

Differentiate with respect to t;

$$-\frac{I}{f_1^2}\frac{df_1}{dt} - \frac{I}{f_2^2}\frac{df_2}{dt} = 0$$

Writing v_1 and v_2 for the speeds of the source and the image, we have

$$\frac{v_1}{v_2} = -\frac{f_1^2}{f_2^2}$$

that is, the speeds are proportional to the squares of the distances from the mirror.

To show the theoretical possibilities of this formula let us suppose a source of light moving with a speed of 10^8 cm. per second at a distance of 10 cm. from the mirror, whose focal length, of course, must be a trifle less than this figure; at what distance must the image be formed in order that its speed shall be 10^{10}, one third of the speed of light?

$$\frac{x^2}{10^2} = \frac{10^{10}}{10^8}$$

$x = 316$ meters, nearly, a distance obtainable in the laboratory with a moderate number of reflections.

The chief difficulty to be overcome in any experiment of this nature would be the faintness of the image due to its great size. A continuously moving source of light could be obtained either by a wheel with mirror teeth or with a self-luminous rim.

Paul R. Heyl.
Central High School, Philadelphia.

THE COMPULSORY RETIREMENT OF THE DIRECTOR OF THE BRITISH MUSEUM OF NATURAL HISTORY.[1]

In a letter which we publish to-day Professor Ray Lankester, who is this year president of the British Association, tells the story of the summary termination of his directorship of the Natural History Museum, some imperfect versions of which have obtained currency. The standing committee of the trustees have taken advantage of the civil service rule that the head of a department may call upon any officer in it to retire at the age of sixty, upon such pension as he is entitled to by the general regulations. That rule is not usually acted upon in the absence of some special reason, unless the officer has completed such a term of service as entitles him to the *maximum* pension. Dr. Lankester was appointed at the age of fifty-two, so that when he reaches sixty next May a regulation intended to apply to men who have spent their lives in a government office decrees that his pension shall be £160, which the treasury of its goodness may raise to £300. In any country but this it would be thought grotesque and monstrous that a distinguished man of science asked to serve the state after the age

[1] From the London *Times*.

of fifty, with his abilities fully tested and his scientific reputation fully established, should be treated on the same footing as a clerk who might never have done anything but copy documents and perhaps post a ledger. In this country there used to be a way of mitigating the absurdity of the system. The treasury could in such cases add twenty-one years to the service for pension purposes, thereby enabling a man joining late in life on some special ground to be put in a position not much worse than that of an undistinguished copyist joining early. But in recent years the treasury has curtailed its own powers and can not now add more than seven years. Were another Newton to-day made master of the mint, and were he to be dismissed or to become incapable of performing his duties five years afterwards, he would receive at the most a pension calculated on twelve years' service. That is how this nation enlists knowledge and ability for the carrying on of its affairs. But that is not by any means the worst it can do. A man may serve it like Lord Milner for a long term of years in difficult and arduous positions, but if he is not technically in the civil service he may be dismissed into private life at an age when other remunerative employment is unattainable, without any compensation at all.

No explanation has been vouchsafed to Dr. Lankester for the cavalier treatment he has received. His eminence in his own scientific field is unquestionable, and has been abundantly recognized by those most competent to judge both abroad and at home. Nor is he one of the unpractical students who do not know how to handle business. On the contrary, he has all the qualities required in an efficient administrator. We are thrown back, therefore, upon reasons of a more personal kind. He was appointed by the three principal trustees in whom power of appointment and dismissal is vested by statute. But the appointment was resented by some active members of the standing committee, which has taken the first opportunity to reverse it. It may be presumed that he has not succeeded in conciliating those who were opposed to his appointment, and as he holds his own views rather strongly and is not too patient with what presents itself to him as stupidity, it is even possible that he has not tried very hard to conciliate them. In most situations in life it is necessary to reckon with these personal factors, which indeed may be raised to the dignity of impersonal factors in circumstances where harmonious cooperation among many becomes as important as the most commanding ability in one man. If the difficulty in the present case is of this order, it may now be regarded as insuperable. Dr. Lankester himself would probably recognize that, whatever the causes, his usefulness at the museum and his own comfort in remaining there are alike at an end. But, though this may be a good reason for the severance of his connection with the museum, it is no reason at all for turning him adrift at the age of sixty with a derisory compensation calculated upon rules intended for a totally different purpose. If he does not 'get on' with the other people in the museum probably there are faults on both sides, and too much zeal for science may have been one of his. In any case failure to get on with somebody else is not by a very long way misconduct of the kind that forfeits a position. He gave up a secure position at Oxford to take the directorship, trusting to a general but not well-founded impression that the state may be relied upon to treat its servants with generosity. There are not many things open to a man of sixty; and there are few suitable to the student of biology. The museum may manage its affairs in its own way, but it is a disgrace to the nation to treat a distinguished man of science, entering its service in exceptional circumstances, as if he were an ordinary clerk, merely because an absurd technicality places both in the same category.

SUMMER MEETING AND COLLOQUIUM OF THE AMERICAN MATHEMATICAL SOCIETY.

THE thirteenth summer meeting of the society will be held at Yale University, New Haven, Conn., on Monday and Tuesday, Septemper 3 and 4.

A colloquium will open on Wednesday, Sep-

tember 5, and close on the following Saturday morning. One course of five lectures will be given by Professor E. H. Moore, of the University of Chicago, and two courses of four lectures each by Professor Max Mason, of Yale University, and Professor E. J. Wilczynski, of the University of California. Titles and outlines of the courses are as follows:

On the Theory of Bilinear Functional Operations: Professor E. H. Moore.

In the light of the general theory of distributive functional operations and with emphasis on various analogies between algebraic and transcendental theories, the course is to consider bilinear functional operations, in particular the theory and applications of linear integral equations, as recently developed by Volterra, Fredholm, Hilbert and others. The general point of view with references is to be found in the article on functional operations by Pincherle in the Encyclopedia, II A $_{11}$.

Selected Topics in the Theory of Boundary Value Problems of Differential Equations: Professor Max Mason.

The course will deal with the real solutions of partial and ordinary linear differential equations of the second order. The analytical character of the solutions of partial differential equations of elliptic, parabolic and hyperbolic types will be discussed. Boundary value problems for equations of these types and for ordinary differential equations will be treated, with special reference to the applications of definite and indefinite integral equations and of Green's functions. The relation between boundary value problems and corresponding problems in the calculus of variations will be considered. Special reference will be made to writings of Hilbert, Picard, Hadamard and Bernstein, and to recent Göttingen dissertations. The lectures will not assume a knowledge of the theory of boundary value problems or of calculus of variations.

Projective Differential Geometry: Professor E. J. Wilczynski.

Differential geometry has, heretofore, been almost exclusively treated from the point of view of the group of motions. In the present course, which is confined to plane and space curves, and ruled surfaces, those properties are investigated which depend upon the infinitesimal elements of the configuration considered but which are invariant under all projective transformations. The references will be principally to the work of Halphen and that of the lecturer, which has been collected in a treatise soon to be published by B. G. Teubner under the same title as this course. Some knowledge of the theory of linear differential equations and of the theory of continuous groups will be assumed.

The morning lectures will begin at 10, the afternoon lectures at 2:30. Each lecture will occupy an hour, and consecutive lectures will be separated by an intermission. Two lectures will be given on each morning, Wednesday to Saturday, inclusive, and on each of two afternoons, and one lecture will be given on Wednesday evening at 8. One afternoon will be devoted to an outing. A charge of three dollars will be made to those attending any or all of these lectures.

James Pierpont,
Percy F. Smith,
Heinrich Maschke,
H. S. White,
F. N. Cole,
Committee on Summer Meeting.

SAMUEL LEWIS PENFIELD.

Samuel Lewis Penfield, professor of mineralogy in the Sheffield Scientific School of Yale University, died at South Woodstock, Conn., on August 12, 1906, at the age of fifty years. He has been continuously connected with the Sheffield School since his graduation from that institution in 1877.

Professor Penfield, as a student, made a specialty of analytical chemistry, and developed wonderful ability in that line of work. Soon after graduation he made many difficult analyses of minerals, particularly of phosphates from Branchville. He studied organic chemistry at Strasburg University in 1880–81, but immediately afterwards he became instructor in mineralogy at New Haven, and thenceforward devoted his whole attention to

that branch of science. He returned to Germany in 1884 to study crystallography and related subjects at the University of Heidelberg.

Penfield accomplished a vast amount of scientific work. Being a master of both the chemical and physical sides of mineralogy, he was able to make the most thorough researches, and he described many new minerals and reinvestigated many old ones. His scientific publications appeared chiefly in the *American Journal of Science,* and many of them were brought together in book form in the 'Studies from the Mineralogical and Petrographical Laboratories of the Sheffield Scientific School.' One of his important achievements was his prediction of the possible existence of an unknown mineral of the humite series, which was afterwards found and described by a European mineralogist.

As a teacher, Penfield was eminently successful. He inspired enthusiasm in his coworkers to a remarkable degree, and a number of his former pupils have become prominent in mineralogy. He devised many means for aiding the student and his laboratory became a model for the best methods of instruction; he revised and enlarged the standard work on Determinative Mineralogy of his teacher, predecessor and friend, Professor Brush; he wrote a number of pamphlets for the use of laboratory students, and besides mineralogical publications, he published important papers on analytical chemistry, cartography and crystal-drawing.

Penfield was a member of the National Academy of Sciences, and was foreign member or correspondent of many European Scientific Societies. He received the degree of LL.D. from the University of Wisconsin in 1904.

H. L. W.

SCIENTIFIC NOTES AND NEWS.

THE University of Greifswald, on the occasion of its celebration of its four hundred and fiftieth anniversary, conferred the degree of doctor of laws on Dr. W. W. Keen, professor of surgery in Jefferson Medical College.

DR. JOHN M. CLARKE, state geologist of New York, has been elected corresponding member of the Royal Academy of Sciences of Göttingen.

THE French Academy of Moral and Political Science has elected Lord Reay a foreign associate member in succession to the late M. Olivecrona. Lord Reay has been a corresponding member of the moral science section of the academy since 1902.

DR. STANISLAO CANNIZZARO, professor of chemistry at Rome and senator of Italy, has celebrated his eightieth birthday.

THE second annual course of lectures given by the Harvey Society of New York will be opened on October 20, 1906, by Professor A. E. Wright, of London. Nine other lectures are to be given during the year, the lectures and dates being as follows: November 3, C. A. Herter; November 17, W. T. Porter; December 1, J. G. Adami; December 15, George Huntington; January 12, F. G. Benedict; January 26, E. B. Wilson; February 9, S. J. Meltzer; February 23, W. T. Councilman; March 9, Friedrich Müller. The officers of the society for the coming year are Graham Lusk, president; Simon Flexner, vice-president; F. S. Lee, treasurer; George B. Wallace, secretary, and C. A. Herter, S. J. Meltzer and James Ewing, council.

THE prize of the Heidelberg Jubilee Foundation for the Encouragement of Scientific Research has been awarded to Dr. Friedrich Pockels, professor of theoretical physics, and to Dr. August Klages, professor of chemistry.

THE University of Strasburg has awarded the income of the Engelmann foundation for history or geography to Dr. Kalkoff, professor in the Gymnasium at Breslau.

DR. D. T. MACDOUGAL, of the department of botanical research of the Carnegie Institution of Washington, left New York on August 18 to carry on some observations in the deserts about Tehuacan south of the city of Mexico, in which he will be joined by Dr. J. N. Rose, of the U. S. National Museum. Dr. MacDougal expects to arrive at the Desert Laboratory, Tucson, Arizona, with the experimental

material secured, in the latter part of September.

Mr. M. L. Fuller, in addition to the supervision of the underground water work of the United States Geological Survey in the eastern United States, will spend a portion of the field season in an investigation of the underground waters of the Cincinnati region and adjacent portions of Ohio and Indiana. Associated with him will be Mr. F. G. Clapp and S. R. Capps. The work will include studies of the rock waters and the waters of the drift, and will be both geological and chemical.

Professor H. E. Gregory, of Yale University, will devote a part of the present field season to the completion of an investigation of the underground waters of Connecticut for the United States Geological Survey. The study of the waters of crystalline rocks has already been completed, leaving only the limestones and Triassic rocks to be examined. A large number of analyses will be made of typical waters with a view to determining their suitability for public supplies, for use in steam boilers or in industrial processes.

Mr. Whitman Cross, geologist, of the U. S. Geological Survey, is making areal surveys in the San Juan district, Colorado. He is assisted by Messrs. Albert Johannsen and L. H. Woolsey.

An areal survey of the Riddles quadrangle, Oregon, is being made this summer by Mr. J. S. Diller, geologist of the U. S. Geological Survey, assisted by Messrs. G. F. Kay and James Storrs. Preparation for this season's work was made last year in tracing the definite Jurassic rocks from the southwest into the Riddles quadrangle, where they come closer together and apparently render it possible to determine their relations. This quadrangle affords an opportunity to study the whole series of igneous rocks of the Klamath Mountains, with which the mineral resources are most intimately associated. A general examination of the mines in the quadrangle will be made.

Dr. A. T. Howard, professor of pathology in the Medical School of Western Reserve University, will spend next year abroad engaged in special investigations.

Dr. C. Graebe, professor of chemistry at Geneva, has retired with the title of honorary professor.

A despatch from Christiania, Norway, says that, according to private letters received there from Spitzbergen, Mr. Walter Wellman has abandoned the attempt to reach the North Pole by balloon this year, owing to the lateness of the season.

A National Society for the Preservation of the Public Health will be established at a meeting to be held at the Hudson Theater, New York City, on November 15.

The United States Civil Service Commission announces examinations as follows: On August 29–30, to fill three vacancies in the position of forest assistant in the Philippine Service, at $1,400 per annum, and similar vacancies as they may occur in that service; on September 12, to fill vacancies in the position of miscellaneous computer at the Naval Observatory; on September 12–14, to fill a vacancy in the position of engineer draftsman, at $1,500 to $2,000 per annum, in the Reclamation Service, Geological Survey; on September 12–13, to fill vacancies, as they may occur, in the position of aid in the Coast and Geodetic Survey, at $720 per annum each; on September 19, to fill a vacancy in the position of assistant photographer (male), at $480 per annum, in the Geological Survey, and vacancies, as they may occur, in any branch of the service requiring similar qualifications; on September 19, to fill a vacancy in the position of economic botanist and mycologist in the Bureau of Science at Manila, P. I., at $1,400 per annum, and vacancies, as they may occur, in the Philippine Service requiring similar qualifications; on September 19–20, to fill vacancies in the position of examiner, at $1,800 per annum, and assistant examiner, at salaries ranging from $1,200 to $1,600 per annum, in the Reclamation Service of the Geological Survey, and similar vacancies, as they may occur; on October 1, to fill vacancies in the position of constructing en-

gineer, in the Reclamation Service of the Geological Survey, at $150 to $250 a month. The great majority of these positions are for field service in the western part of the United States and in places remote from cities and ordinary lines of transportation.

LORD KELVIN writes as follows to the London *Times:* "In your yesterday's issue, under heading 'British Association,' I read 'In the Mathematical and Physical Section, a discussion was opened by Professor Soddy on the possible transmutation of the elements. * * * The statement that the production of helium from radium has established the fact of the gradual evolution of one element into others was not seriously questioned.' I wish to remark that an isolated experimental discovery by Sir William Ramsay and Professor Soddy, brilliantly interesting as it is and solidly instructive as it is towards the theory of radium, suggests nothing more towards any modification of the atomic doctrine proposed some 2,500 years ago by Democritus, and universally adopted by chemists and other philosophers in the nineteenth century, than does Ramsay's original discovery of helium as an emanation from the mineral clevite. The obvious conclusion from the two discoveries is that clevite and radium both contain helium. I can not refer, thus publicly, to discussions on radium in the meeting of the British Association which commenced last Wednesday in York without protesting against the hypothesis that the heat of the sun or earth, or other bodies in the universe, is due to radium. I believe it is mainly due to gravitation; and I believe that the experimental results on which the radium hypothesis has been built give no foundation on which it can rest."

AN experimental and teaching station for the study of economic plants and the home production of medicinal and industrial vegetable products was opened last month near Landskrona in Sweden. The establishment, erected by the provisions of Consul Oscar Ekman, of Stockholm, was dedicated to the Swedish nation under the name Esperanza. Consul Ekman, now in his ninety-fourth year and formerly associated with the Carnegie industrial interests, previously donated considerable sums to the universities of Upsala and Göteborg, and has been active for many years also in the promotion of popular enlightenment. In the establishment of the new station he was guided mainly by a desire of resuscitating the home culture of useful plants formerly quite common, as well as by the fact that raw materials of this class are now being imported into Sweden at a great cost. Among the problems first to be considered are the cultivation of mint. The oil of peppermint never was produced on a scale sufficient for the demand, and Sweden's supply thereof is nearly all imported. The home production of chamomilla, a plant formerly cultivated about every country home; the cultivation on a large scale of caraway, pigment plants, textile and fiber herbs is also considered. Two directors have been appointed. The botanical work is in charge of Director Tom von Post, of the Upsala Seed Control Station, who made an investigation, last year, of the principal European centers of peppermint culture. Mr. Hjalmar Lindström, a practical pharmacist of Landskrona, will have charge of the technical and industrial branches of the work.

D. H. Ross, Canadian commercial agent at Melbourne, reports that two Australian inventors have discovered a new process for the continuous treatment of iron ore, and he says that the results they have achieved are so successful that the process is to be exploited throughout the world. It is called the Heskett-Moore process for directly converting iron ore into malleable iron or steel by a continuous system, and it is claimed effects a saving of 25 per cent. in the manufacture. The ore is simply concentrated by ordinary methods, or if it is magnetic it is separated electrically until the pure oxide of iron is obtained. The oxide of iron is passed through a revolving cylinder heated by waste gases from subsequent operations and brought in that cylinder to a dull red heat. It drops from the cylinder to a second similar cylinder, and in the latter it is brought into contact with the deoxidizing gas, which is forced

through and brought into contact with the heated ore. The heated ore is thus converted into a pure iron. Accompanied by and protected by the deoxidizing gas, it is passed into a third chamber or melting hearth, where it falls into a bath of molten iron and is converted directly into steel or balled up as malleable iron. The savings claimed for the process are those of time, labor—the whole process being automatic—fuel and avoidance of flux. The inventors claim that they have discovered a direct method of producing steel from one operation instead of using the blast furnace and converter.

UNIVERSITY AND EDUCATIONAL NEWS.

THE following additions have been made to the faculty of Stanford University, to begin work with the coming academic year:

George Hempl, of the University of Michigan, as senior professor in German.

Allyn Abbott Young, of the University of Wisconsin, as associate professor of economics.

Thorstein Veblen, of the University of Chicago, as associate professor of economics.

William Dinsmore Briggs, of Western Reserve University, as assistant professor of English.

C. A. Huston, of the University of Chicago, as instructor in law.

Payson J. Treat, of Stanford University, instructor in history.

Frank E. Thompson, of the State Normal School of San Diego, instructor in education.

Hubert H. Hall and L. L. Carter, both of Stanford University, instructors in civil engineering.

Lawrence E. Cutter, of Stanford University, instructor in mechanical engineering.

Frederick A. Manchester, of the University of Wisconsin, instructor in English.

Pierre Comert, of the University of Paris, instructor in French.

Homer P. Earle, of Stanford University, instructor in Spanish.

W. O. Mendenhall, of Haverford College, instructor in applied mathematics.

Rennie W. Doane, of Stanford University, instructor in entomology.

William E. Burke and William H. Sloan, both of Stanford University, instructors in chemistry.

Luther Burbank, of Santa-Rosa, lecturer on plant evolution.

Ephraim Douglass Adams has been promoted to a professorship in history and Edward Curtis Franklin to a professorship in organic chemistry; Hans Frederik Blichfeldt to an associate professorship in mathematics; and Charles Henry Huberich to an associate professorship in law. Henry Suzzallo has been promoted to an assistant professorship in education; Anstruther A. Lawson to an assistant professorship in botany; Kenneth Livermore Curtis to an assistant professorship in electrical engineering; Arthur Martin Cathcart to an assistant professorship in law; and Henry David Gray to an assistant professorship in English. The work of repairs of earthquake damages at Stanford University has been placed in the hands of a commission of the engineering faculty composed of Professors Charles David Marx, William F. Durand and Charles B. Wing. The repairs have progressed so far that all necessary rooms are ready for the work of the coming academic year, which begins on August 23, 1906.

LEMENUEL W. FAMULENER, B.S. (Michigan, '02), Ph.C. (Michigan, 1900), M.D. (Michigan, '06), has been appointed assistant professor of pathology in Indiana University. Dr. Famulener was for three years Nelson Baker and Co. research fellow in pharmacology under Dr. Cushny at the University of Michigan, and for one year a worker with Dr. Mansen in the Statens Seruminstitut at Copenhagen, Denmark.

DR. BRUCE FINK, of Iowa College, has been appointed professor of botany at Miami University, Oxford, Ohio.

JAMES T. ROOD, Ph.D., has been elected professor of mathematics and physics at Ursinus College, Collegeville, Pa.

MR. DIARMID NOËL PATON, superintendent of the laboratory of the Royal College of Physicians, Edinburgh, has been appointed regius professor of physiology in the University of Glasgow, in place of Professor J. G. M'Kendrick, resigned.

DR. EUGENE ALBRECHT, director of the Senckenbergische Institut at Frankfort, has been called to the chair of pathology at Marburg.

DR. GUSTAV STEINMANN, of Freiburg, has been called to a chair of geology at Halle.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 31, 1906.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ECONOMICS AS A SCIENCE.[1]

THAT economic and social studies should be carried on with the scientific method and spirit is not likely to be denied by any one here present. And yet there are persons who would have us believe that these important fields of investigation are by nature incapable of such a treatment. Even among economic students we find many writers of the type of Cliffe Leslie, who definitely disclaim that economics is a science, and class it rather as a branch of history. There has always been more or less hesitation as to the place economic studies should occupy as between the historical and scientific poles. The tendency to lean toward the historical side is indicated by the fact that the American Economic Association has regularly met in conjunction with the American Historical Association, while the tendency toward the scientific side is indicated by the fact that this section exists as a branch of the American Association for the Advancement of Science.

Those who maintain that economics is not and never can be a true science base their contention on the fact that social phenomena are not constant, 'like,' they say, 'the phenomena of astronomy or physics,' but differ widely at different times and under different circumstances. They point out that the determination of prices

[1] Address of the chairman of Section I of the American Association for the Advancement of Science, at the Ithaca meeting, July, 1906.

under modern free competition is quite different from their determination under the medieval system of custom and status; that the remuneration of labor depends on what are the historical and legal institutions with respect to slavery, labor legislation, etc.; that the economic phenomena of to-day are not comparable with those of the times of the Greeks and Romans, nor are the phenomena in America comparable with those in Russia.

To one who is familiar with the spirit of science, however, these variations, so far from being objections, are really confirmations of the theory that economics is a science. For in all science it is fundamentally true that phenomena will 'differ according to circumstances,' and the office of the scientist is simply and solely to find out under what circumstances one set of phenomena will occur, and under what circumstances another set will occur. We could hardly claim that hydrostatics is not a science for the reason that in a mountain lake water is found to be stationary and at a level, whereas at Niagara it is found to be in motion and passing from one level to another; that whereas the water in a mill-race passes in a downward direction, the water which we draw in our houses moves through the pipes upward; that whereas, by means of a syphon, water may be induced to flow out of a receptacle, it will, in an ordinary tub, remain inert. The whole science of hydrostatics has developed as a consequence of the persistent effort to unravel these puzzles, and to-day we know not only that under different circumstances water will act in different ways, but we can formulate what are the precise conditions under which it will act in each separate manner.

In economic study we should in like manner apply ourselves to discover what conditions make the difference in the phenomena between modern and ancient or eastern and western civilizations, rather than content ourselves with the truism that they do differ. Much of the field has in fact already been covered. It is known, for instance, that under conditions of free contract and competition, the price of an article will be determined by the intersection of its supply and demand curves, and that, on the other hand, if the régime be one of monopoly, the price will be determined on the principle of 'what the traffic will bear,' in the manner so admirably shown by Cournot. In these cases the results are not absolute and unconditional, but depend on specified hypotheses. In this respect they are exactly similar to any other scientific result. The formula of science, as Newcomb points out, is always conditional—if A is true, then B is true. The formula of history, on the other hand, is unconditional—simply B is true.

If economics is a science, its truths must be conditional. Thus, the incidence of a tax on ground rent will lower the value of land, *provided* there are no counteracting causes. This does not assert that actually, after such a tax, the value of the land will fall, for in the meantime some opposing cause may have intervened, such as the discovery of an oil-well. Again, an increase of the quantity of circulating medium will raise prices proportionately, provided the velocity of circulation and the volume of business transactions remain the same. This 'quantity theory' does not assert that prices *do* rise after every increase in the quantity of money, and those who thus interpret it are guilty of the confusion already noted between conditional and unconditional truth—in other words, between a scientific law and a historical fact.

The confusion between historical and scientific truth is very common among economists, especially in the German historical school. While Roscher and his followers verbally classify economics as a sci-

ence, they leave no place for economic *theory*. Curiously enough, they imagine that by confining themselves to historical generalizations they are following the inductive method of Bacon. A closer study of Bacon's work would have revealed to them that true science does not consist in the mere grouping of historical phenomena. In fact, Bacon makes a distinction between what he calls the popular and the inductive method, or what may be preferably called, following the example of John Rae, the *systematic* and the *scientific*. The two are commonly confused, but are entirely distinct. 'System' consists in classifying phenomena; 'science' consists in discovering the laws to which they conform. System explains phenomena by means of what is common and familiar; science explains them by what is simple, however recondite. System is exemplified in such descriptive studies as grammar, descriptive geography and history; science is exemplified by such analytical studies as mathematics, physics, and latterly, biology. The classifier or system-maker is content with generalization of facts. These express the *usual* order of events, for instance, that the sun rises once a day. They do not express the reason or principle. The difference between system and science is the difference between a general fact and a necessary truth, between *rules* and *laws*. Exceptions to rules do not destroy them as rules; in fact, we say 'the exception *proves* the rule.' This, however, is not true of laws. A 'law' which has an exception is no law at all.

Many studies which are now scientific had their origin in what was originally systematic. The predecessors of the modern physicists classified bodies into 'light' and 'heavy.' Iron, they maintained, is heavy and therefore falls; fire is not heavy, and therefore rises. How different is this obsolete method of treating the subject from our modern analytic notion of gravity, or rate of increase of velocity, by means of which are explained both the falling of iron and the rising of 'fire.'

Similarly, the prototype of biology was 'natural history,' and consisted chiefly in the mere classification of animals and plants into species, genera, etc. Modern biology has supplanted such elaborate classification by introducing, through Darwin, the analytical ideas of heredity, variation and selection, and in this way the descriptive study of natural history has been converted into the true science of biology.

The same evolution which has been outlined in physical and biological science is doubtless taking place in economic science. Yet it must be confessed that few have yet mastered the distinction between a general fact and a scientific law. When we hear it stated as fundamental in political economy that skilled labor is better paid than unskilled, it is clear that this is merely a general rule and not a necessary law. The single fact that certain seamstresses, though skilled, are illpaid, is sufficient to disprove the statement as a necessary law, though it does not affect it as a general fact.

The historical school justly complains of the superficial character of the theories which have been sometimes offered. This objection holds, however, not against theory as such, but against *false* theories; and herein lies the virtue of Bacon's method. The inductive method, by which any theory of phenomena must be checked by reference to actual historical fact, thus forms the means of distinguishing between truth and falsity. Rejecting false theories is quite different from rejecting all theories. What is needed now in political economy is to rid ourselves of the false and superficial theories, on the one hand, which have been constructed *a priori* and irrespective of facts; and, on the other

hand, to release ourselves from the cheap empiricism of the historical school, who interpret their task as merely one of generalizing phenomena without analyzing them. In the words of the great philosopher, Hume, 'Our speculations can scarce ever be too fine, provided they be just.'

Science is one. The logic for economic science should be the logic for all science—a combination of induction and deduction. Facts are at once the test and the material of science, but laws are its ultimate goal. Laws are not facts, but the relations between facts. Newton's first law of motion, that a body tends to move uniformly in a straight line, is not a fact, nor is it a general expression of facts. Probably no particle in the universe has ever moved exactly in a straight line or with uniform velocity for so much as a single second. Yet it would be an error to conclude that Newton's law is unreal and untrue in actual nature. The law has an 'if' in it—'*if* a body were acted on by no force, or by perfectly balanced forces, its motion *would* be uniform in both rate and direction.' Withdrawn thus from actual events, Newton's law seems to the non-scientific mind to lose all objective truth. This again is an error. Newton's law is absolutely true to nature. The fact that it is conditional does not make it arbitrary. We are not free to replace it by the medieval opinion, viz., 'If a body is let alone it will gradually spend its force and slacken its speed.' This formulation, unlike Newton's law, would not stand the test of facts. A valid law is true at all times and places, in the sense that should the particular conditions arise, the prescribed result would follow, but not in the sense that the particular conditions must needs ever arise.

When the relations between scientific and historical truth are more fully realized, we may expect economic studies to make more rapid strides than have hitherto been possible. We shall recognize the two-fold nature of most practical economic problems, such as the present problems of trades-unions, insurance, railroad rate regulation and the tariff. These problems require first of all the study of historical facts, and secondly, the discovery of the relations to which these facts conform. When these two studies are complete we are prepared to take a third and final step, *prediction*. It is sometimes said that the ability to predict is the final test of science. But it is not a test of science only. Successful prediction requires two conditions: one is a knowledge of science—of what will happen under given circumstances; and the other, equally essential, is a knowledge of history—of the particular circumstances of the present moment, out of which the future, to be predicted, will grow. Failures of prediction are due to the lack of either of these two essential conditions.

An example of a failure of prediction due to imperfect knowledge of facts is found in the case of the closure of the Indian mints to silver in 1893. It was expected that the value of the silver rupee would be maintained at 16 pence. But no account was taken of the large coined hoards of silver among the natives. After these had been put into circulation the price of the rupee did eventually rise to 16 pence and has remained there ever since. In this case the failure of prediction at first was due, not to any defect in monetary *science*, but to ignorance of Indian *history*.

Usually, however, failures in economic prediction are due to the lack of scientific rather than of historical knowledge. In the civil war, when there was a premium on gold, the scientific explanation of which was really simple, the public attributed the premium to the machinations of speculators. Accordingly, Congress was induced to close the Gold Exchange, whereupon,

to the consternation of the framers of this foolish prohibition, the premium on gold soared higher than ever. The result was a hasty and shamefaced repeal.

Experience of this kind is too common in economic legislation. It serves as a warning that we should know something of economic science before venturing to tamper with economic conditions. The men who need this warning most of all are those who despise all 'theories' and call themselves 'practical.' It is they who legislate a measure one day and have to repeal it the next. A *truly* practical man can predict how a measure will work, and his power so to do requires not only what is called 'practical' but also what is called 'theoretical' knowledge; a knowledge, in short, not only of *history* but of *science*.

IRVING FISHER.

YALE UNIVERSITY.

SECTION D—MECHANICAL SCIENCE AND ENGINEERING.

THE meetings of the section were held in the lecture room of Sibley College of Mechanical Engineering and Mechanic Arts, of Cornell University, on Friday and Saturday, June 29 and 30. They were followed by the fourteenth annual meeting of the Society for the Promotion of Engineering Education, an affiliated society of the association.

In the absence of the vice-president, the retiring vice-president, Fred W. McNair, president of the Michigan College of Mines, acted as chairman of the section. Twenty-three members of the association registered as belonging to the section, while members of other sections attended some of the meetings. Experience gained at this meeting has shown that it is not conducive to the greatest attendance to have Sunday intervene between the meetings of the section and of the affiliated society.

The first two papers were by Byron B. Brackett, professor of physics and electrical engineering of the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y. The first paper describes a 'Lamp Bank composed of Small Separate Units.' Each unit consists of twelve incandescent lamps arranged in a partially open box, 28 inches long and 10 inches square. The boxes are open enough to give perfect ventilation. On one side are placed switches for cutting in or out the lamps of that particular box, and for changing the grouping of the lamps into parallel, series or combination arrangements. As many of these units as are desired may be placed one upon the other in tiers, and as many tiers as are needed may be placed side by side to form a lamp bank of any capacity. Each unit is constructed to permit convenient interconnection with the adjacent ones. Thus, the large bank may be separated into smaller ones whenever desired and reassembled with the least possible loss of time and effort for special tests on large machines.

His second paper was on an 'Alternating Current Wave-form Apparatus.'

To set the armature accurately for the separate readings in the ballistic method of tracing the E.M.F. wave of an alternator, a double or duplicate brake apparatus is unusually satisfactory. Two similar clamp brakes with long arms are placed on the pulley side by side. With the arms held rigidly the desired readings for one observation are made. Then brake No. 1 is unclamped at the pulley, the end of its arm released and rotated up a short distance to a fixed stop. Brake No. 1 is now clamped to the pulley, brake No. 2 is unclamped, the end of No. 1 turned down to its original position and No. 2 is clamped again. Thus the armature has been rotated through a small angle, that may be computed with great accuracy from the length of the arms and the distance

through which the end of the arm of No. 1 is moved. The same method may be used wherever small accurate rotations of any shaft are desired and the same apparatus may be used on dynamos, engines and other forms of machinery.

A report was made by Mansfield Merriman, professor of civil engineering, Lehigh University, South Bethlehem, Pa., on 'Constant and Probable Errors in the Estimation of Linear Distances and Vertical Angles, as ascertained by 1,712 Observations on 128 Students.'

The observations were made by asking students to record their estimates of the length, width and thickness of a board, and also of the magnitude of several vertical angles. The angles were estimated in degrees and also by the ratio of horizontal to vertical projection. The following conclusions were drawn:

1. For lengths, about sixty per cent. of the estimates were too large, and the average constant error was always positive.

2. For angles, about eighty per cent. of the degree estimates, and about sixty per cent. of the ratio estimates, were too large.

3. The estimates of vertical angles by the ratio method are more accurate than those by degrees.

4. The probable error of a single estimate is larger than the average constant error.

5. The estimates of the freshmen class had much larger errors than those of other classes.

This interesting example of the application of laboratory methods to the classroom created much interest on the part of the engineering teachers present.

The next paper was read by the secretary, and described and discussed the results of 'Some Experiments on the Frictionless Orifice' and was by Horace Judd and Roy S. King, assistant professors of experimental engineering at Ohio State University. The paper is in sequence with one presented by one[1] of the authors at the St. Louis meeting, on 'Pitot Tubes; with Experimental Determinations of the Form and Velocity of the Jets,' and which was published in the *Engineering News* of March 31, 1904, page 318.

The experiments described in the paper were made on five frictionless orifices, ranging in size from three fourths inch to two and one half inches in diameter. The term 'frictionless orifice' is one which has been commonly used in the mechanical laboratory at the Ohio State University for many years. It is the same as what some of the text-books call 'an orifice in a thin plate,' and indicates that there is no appreciable loss by friction by a stream of water flowing through such an orifice. So far as known, the term was first employed as early as 1873 by Professor S. W. Robinson, emeritus professor of mechanical engineering at the Ohio State University, and will be found on page 552 of Vol. VI. of the Geological Reports of Ohio, 1886, in his report on the 'Measurement of Gas Wells and other Gas Streams and the Piping of Natural Gas.'

The facilities available consisted of a closed standpipe into which several pumps could force water. A horizontal drum was connected near the bottom of the standpipe, and in the end of the drum the orifice to be tested was secured; the coordinates of the issuing jets were measured by the hydraulic micrometer caliper, described in a paper presented by Professor Wm. T. Magruder at the St. Louis meeting of the association.[2] The water was caught and measured in a calibrated cistern.

The experiments were made to find:

[1] Science, N. S., Vol. XIX., No. 479, March 4, 1904, p. 364.

[2] Science, Vol. XIX., No. 479, March 4, 1904, p. 364.

1. The coefficient of discharge by direct measurement in a calibrated hydraulic cistern, (*a*) to verify existing constants, and (*b*) to find the coefficient of velocity for comparison with that given by the Pitot tube, and (*c*) to verify its constant. The results show a decrease in the coefficient of discharge of 2.5 per cent. with an increase in the diameter of the orifice from three fourths inch to two and one half inches. The average value obtained was 0.60664, and is about 1.8 per cent. greater than that given in Merriman's 'Hydraulics' (0.5960). Compared with that of Bovey (0.6000), the result obtained with the jet from the one inch orifice (0.6097) is 1.6 per cent. higher.

2. The shape of the jet in the vicinity of the least section as found by exploring the contour of the jet by the special micrometer caliper. It was found that the distance from the face of the orifice to the least section of the jet varied from 1.6 radii for the three fourths inch orifice to about one radius for that two and one half inches in diameter. Text-books on hydraulics give this distance as being one radius, while Bazin found no 'minimum section' of the jet flowing through a large orifice and under low head.

3. The diameter at least section, as found by the special caliper for four different positions, 45° apart. From the average diameters, the coefficients of contraction were computed, and they were found to decrease from 0.6134 for the three fourths inch orifice to 0.5955 for the two and one half inch orifice, with an average value of 0.60674. As calculated from the average results for the coefficients of discharge, the coefficient of velocity is the quotient of the coefficients of discharge and contraction, or 0.60664 divided by 0.60674 equals 0.99983. From this result it is thought that the term 'frictionless orifice' is justifiable.

4. The effect of increase of static pressure on least section. No appreciable increase was found in the diameter of the least section of the jet from a one inch orifice by increasing the pressure from 5 pounds to 100 pounds; and, for pressures as high as 40 pounds, only a slight increase was noticed for the orifices one and one half inches to two and one half inches in diameter. This latter was probably due in part to the increased roughness of the contour of the larger streams.

5. The velocity in the least section was found by traversing the jet with a one fourths inch Pitot tube used in connection with a differential manometer. It is thought that the coefficient of velocity as determined by the Pitot tube is unity within a negligible fraction of 1 per cent. and that the velocity is uniform throughout the section. As calculated from the average values of the coefficients of discharge and contraction as determined by experiment, the coefficient of velocity was found to be 0.99983. This compares very well with the average value of the coefficient of velocity, 0.99993, determined by means of the Pitot tube. This would seem to verify the statement that the Pitot constant is unity.

The paper shows that it is the result of most careful and elaborate investigations. It also shows the inaccuracy of certain statements which are still being published in books on hydraulics concerning the vena contracta. While adding new facts to our knowledge, it gives us a method for measuring quantities of water discharged, and with a probable error which is known to be small and less than the probable error of observation. The paper is worthy of careful study and attention. It will probably be published in the *Engineering News*.

The next paper on the program was on 'Some Aspects of the Panama Canal,' by Wm. H. Burr, professor of civil engineering, Columbia University, New York, N.

Y., and a former member of the Isthmian Canal Commission. As the paper has been published in full, and will be found on page 71 of the issue of SCIENCE for July 20, 1906, its contents need not be detailed here. Suffice it to say that the recent dreadful earthquake disaster at San Francisco constitutes the gravest warning in human experience of the advisability of constructing this canal in such a way as to give it the greatest degree of immunity from the results of any convulsions of nature, and the still more recent earthquake shocks on the isthmus should be sufficient to set even politicians to thinking what would be at least one result of an earthquake to the gates and walls of a lock canal having 85 feet of lift.

In this connection it should be noted that while no efforts have been made to secure authors of papers who were in favor of the sea-level canal, yet all the papers which have been presented before this section in the last few years have logically given most excellent reasons why the canal should be built with the fewest possible locks and of the least lift. Time will decide whether the prediction is correct which has been made before this section that the high lock level canal will have to be rebuilt before it has been in use ten years.

Henry T. Eddy, professor of engineering and mechanics, University of Minnesota, Minneapolis, Minn., presented a paper on 'The Theory of the Flexure of the Symmetrically Loaded Plate, and the Heavy Horizontal Disc of Varying Thickness.' Although the theory of the elastic flexure of the thin flat plate of uniform thickness has been long known to the same degree of approximation as that of the common theory of flexure of beams, the theory of the heavy horizontal disc on a vertical axis and of a thickness decreasing from the axis of the rim has, up to the present time, been in a somewhat unsatisfactory state from the point of view of the engineer who would design discs like those employed in the Curtis steam turbine. The object of this paper is to make a contribution to this theory, which it is hoped will facilitate both the algebraic and numerical treatment of such units of construction.

A paper was read and illustrated by Henry S. Jacoby, professor of bridge engineering, Cornell University, Ithaca, N. Y., on the 'Applicability of Displacement Diagrams in the Design of the Flanges of Arch Ribs with Solid Webs.'

The usual method of finding the stresses in the flanges of arch ribs with solid web plates involves the computation of bending moments and axial thrusts at a number of sections due to dead and live loads, and also when there are less than three hinges, for changes of temperature and rib shortening. The formulas for the determination of the horizontal reactions, while comparatively simple for ribs with a parabolic axis, are complex for a circular axis, and entirely impracticable for other curves such as three or five centered ovals. The method proposed is to assume the solid web plate to be temporarily replaced by an imaginary inelastic system of open webbing, the panel points of each chord being located in the centers of gravity of the corresponding flange sections. It allows the horizontal reactions to be found by means of displacement diagrams which apply to any form of arch rib. The method also affords the simplest means of finding the deflections under any loading.

'Some Notes on the Teaching of the Cyclic Analysis of the Gas Engine' was next presented by Arthur J. Wood, assistant professor of experimental engineering, Pennsylvania State College, State College, Pa.

As a basis for this study and discussion, the results of tests of a five-horse-power

gasoline engine were presented in full. The distribution of heat thus obtained is compared with results obtained by an entropy-temperature analysis of one of the indicator diagrams in which the losses are shown graphically. The paper brings out the method for finding the temperature at any point in the card; the heat of the mixture in the cylinder; the average value for the exponent of the adiabatic curves of expansion and of compression and values for different parts of these curves; the method of obtaining the entropy for all points; and a comparison of results of some recent tests at the Pennsylvania State College.

Certain conclusions are drawn from the study of the subject: (1) the losses can not be computed accurately unless the data are taken more completely and with greater care than is usual with such tests; (2) about 20 per cent. of the heat of the gasoline vapor is available for useful work at full load; (3) the common method of obtaining, by test, the heat in the exhaust gases is not satisfactory; (4) the teaching of the entropy-temperature analysis without requiring the student to make the analysis is a pure waste of time (the average student in the senior class ought to master the whole theory in a few hours, and make the analysis in a few days' time, and this will open to him some of the neatest applications of thermodynamics; a complete analysis by a student is presented in the paper); (5) the value of the exponent of the true adiabatic curve is obtained from the ratio of the specific heat at constant pressure to the specific heat at constant volume, and if this curve is constructed it will bring out at a glance where heat is taken in or given out, without resorting to the entropy-temperature diagram. Brief reference is made to the method known as 'cyclic analysis,' in which the principal results as mean effective pressure are obtained from the heat put in, the initial temperature, the value of the specific heat at constant volume and the temperature after compression. The author has found this method to contain nothing attractive as a system for teaching, because, (1) it makes the student a mere machine, substituting in derived formulas; (2) the value of the heat for each cycle can not be obtained accurately by this method; and (3) it does not open up clear, well-defined lines of application of the principles of thermodynamics. The paper as a whole aims to make it clear what data must be obtained in order to make an entropy temperature analysis and how it may be made practical as a method of instruction and valuable in design. It further shows how the principles of thermodynamics can be made as clear in showing changes of heat energy as of mechanical energy. In all this the writer does not depreciate the value of the purely analytical methods.

The next paper was by W. W. Churchill, vice-president and chief engineer of the Westinghouse, Church, Kerr Company of New York, on 'The Preservation of Surface Condenser Tubes in Plants using Salt or Contaminated Water Circulation.' The paper will be published in full in the October issue of *Power*.

Owing to electrolytic and galvanic action on the tubes of a surface condenser using water containing salt or sewage for circulation, the use of surface condensers in large power plants has been very largely abandoned as useless. Under ordinary circumstances the water bill of such a plant as that described for the Long Island City power house of the Pennsylvania Railroad, containing when fully constructed fourteen 5,500 K.W. generating sets, would be in the neighborhood of $100,000. An investigation was undertaken of possible methods for preventing the rapid destruction of the condenser tubes and parts of the condenser.

The most competent opinion that could be obtained was that if the differences of potential due to stray ground traction or other currents could be adjusted to be within three volts or less, the difficulty would cease, as the trouble was all due to stray grounded currents from electric railways. To that end, the stray currents were measured, and at times a difference of potential of nine volts higher than the harbor was discovered between the railroad rails in the freight yard and the river, producing a considerable flow of current from all parts of the water piping and other metallic substances in the vicinity of the power house site to the harbor.

In order to properly study the real conditions, a number of glass jars were provided and various combinations of metals were immersed in samples of water taken from the river, of sea water, and of pure water. The action of the river water was much more violent than ordinary sea water. It was further observed that there was a local action going on which was galvanic, and that the amount of stray currents caused the galvanic action to be exceedingly violent, and that thin copper tubes were destroyed at a very rapid rate. They would be punctured in from four to five days, which would make their use fatal in commercial practise. It is thus evident that there was a violent action between the zinc and copper of the brass tubes which were in contact with the electrolyte. Even when unconnected, or electrically separated, plates of brass were placed in this electrolyte, any projections were promptly destroyed. But if an electric battery having a pressure exceeding that of the couple in the East River water was caused to act to produce a counter current, and having a pressure exceeding that of the galvanic couple, the capacity of this electrolyte to drive off atoms of the mechanically combined metals of the alloys used was overcome and corrosion was arrested. To do this it was planned in this case, where this couple is about 0.4 of a volt, to put a counter pressure of 0.6 of a volt on the anode. In order to insulate the condenser as much as possible from stray currents from the railway, the joints in the piping and the ground contacts were insulated, and even the large water connections were lined with glass melted on to the surface. To furnish the desired electromotive force a three-K.W. motor-generator was installed and provided with switchboard apparatus and appliances, together with ammeters and voltmeters, and a connection to the outlying anode in the condensing supply intake at its harbor end. This led to considerable discussion as to the methods and reasons why the corrosion was prevented. Reference was made to Faraday's laws, and to the results of the experiments of Helmholtz and Clausius. The best explanation is given in Professor Oliver J. Lodge's 'Modern Views of Electricity.' All the apparatus was designed in accordance with his theory and statements. Its operation has extended over a period of fourteen months, and with the exception of about ten tubes which have become pitted, the results have been satisfactory. When the condenser was planned, the condenser manufacturer was told to slope the tubes down one inch in the direction of flow; but when they performed the act, they forgot that the middle inclination, if parallel to the first and third passes, would then be uphill for the circulating water, and that when the condenser was shut down all the water would drain out of this middle section except that in the bottom tubes. These bottom tubes, it has been found, have become somewhat corroded, although not seriously.

The cause for this result having now been found, its prevention has been effected by perforating the diaphragm in the

condenser head to permit prompt drainage of these tubes when the condenser is taken out of active operation. Considerable difficulty has been encountered in getting the system operated properly at the voltage suitable for the prevention of galvanic action in the hands of the regular operators, as they persisted for a long period in reading amperes instead of volts in adjusting the currents, thus not providing except by accident for the requirements. The efficiency of the apparatus amply justifies the expense of its installation, while its operation is not expensive and the plant here described will now be followed by other protecting plants of the same character.

This paper forms a most excellent illustration of the application of theoretical physics to the solution of a concrete problem in commercial engineering. The saving of $100,000 a year in water rates at the expenditure of $250, or even more, per year, in a scientific preventive should be a sufficient answer to the commercial man who asks 'Does science pay?'

The paper on "The Justification of the Use of the Expression 'Engineering Mathematics,'" by Arthur E. Haynes, professor of engineering mathematics, University of Minnesota, Minneapolis, Minn., describes the conditions as they exist in a large university of the central west wherein mathematics is taught to students pursuing all kinds and classes of courses. The paper will be published in full in the *Proceedings of the Society for the Promotion of Engineering Education.*

The last paper, and in some respects one of the most interesting and valuable papers presented before Section D, was by J. J. Clark, manager of the text-book department of the International Correspondence Schools, Scranton, Pa., on 'The Correspondence School: Its Relation to Technical Education, and Some of Its Results.' The paper will be published in full in the *Proceedings of the Society for the Promotion of Engineering Education* and will doubtless be abstracted by the technical press.

When Professor Edgar Marburg read a paper[1] in 1899 on 'The Correspondence School in Technical Education' there were about 80,000 students enrolled in the International Correspondence Schools. In the following year this number had increased to 181,000. Owing to a number of circumstances, it was impossible at that time to furnish reliable figures in regard to the work being accomplished. Hence the reports which were made were both unsatisfactory and unjust to the correspondence school. Since December 31, 1899, the school has grown at a rate of more than 100,000 per annum, the total number enrolled on June 27, 1906, was 902,906. After relating something of the history of the growth of the schools and their methods of securing students, the author describes their system of education as being based on ideas that are almost the direct opposite to those practised by the regular schools and colleges. The regular technical school or college aims to educate a man broadly; the aim of the correspondence schools of the country is to educate him along some one particular line, and to make each course fit the particular needs of the student who takes it. Hence, with a few exceptions, almost every one of the courses is a special course.

The author then describes other methods of conducting correspondence schools by the use of the regular text-books and correspondence concerning the difficulties encountered by the student. The author states that such schools have always failed or made very little progress, 'for the reason that the ordinary text-book is not

[1] *Proceedings of the Society for the Promotion of Engineering Education*, Vol. VII., p. 80.

adapted to the use of the person studying by himself.' Another method is that of the University of Chicago, where students may take part of their regular college course at home. He can not, however, get his degree without taking the balance in residence. This plan offers few advantages over the regular college course. The only requirement necessary to become a student of the International Corespondence School is the ability to read the English language and to write it sufficiently well to be understood, or to possess the services of some one capable and willing to translate from the text-books and write out the dictation in English of the foreign-speaking student who is unable to use the English language.

The text-books differ, even on the same subject for the courses for which they are to be used; not only on the method of treatment, but principally in the examples given and the illustrations cited.

The author gives a number of reasons why students do not complete their courses, and also mentions cases of students who admit deriving much benefit from the course but who have never submitted an examination paper for correction. Their instruction has been obtained solely from the bound volumes which were furnished them when they enrolled. About 60 per cent. of the students send in one or more pieces of work. About two thirds of the students pay in full for their courses. While the present enrollment is a little over 900,000, the actual number of students is probably 60 per cent of this, or 540,000. During the year ending May 31, 1906, the total number of pieces of work received from students was 716,952. About one sixth of the number of active students have completed about one third or more of their course as shown by the records. The number of students who have entirely completed their courses, passed their final examinations and been awarded a certificate or diploma was 12,143 on June 27, or about 2.6 per cent. of the total number of active students. Between February 7 and April 21 the number of diplomas issued averaged 240 per month. The average for next year is estimated as high as 300 per month, or 2,700 diplomas for the year from this one correspondence school. As this number is about the same as the number of engineering degrees conferred per annum by all the technical colleges of the country, the amount of work that this represents, and the amount of education which is being obtained can be somewhat appreciated.

The social sides of the meeting were very well cared for by the committees of Cornell University, and have been described in the report of the general secretary. A special excursion was tendered to the section by the committee on Saturday afternoon in the form of a steamboat ride on the steamer *Iroquois*, down the lake, and which included a visit to the Remington Salt Works near Ithaca. Here steam is generated and used in steam engines for the generation of electric power, and the exhaust steam is used in the vacuum pans of the salt works. A feature of the meeting which appealed to every one was the delightful entertainment accorded to the members in the houses of the fraternities. Altogether the meeting was most enjoyable and profitable, and both the section and the Society for the Promotion of Engineering Education desire to extend their special thanks to the trustees, the faculty and to the fraternities who opened their houses at Cornell University.

Wm. T. Magruder,
Secretary.

Ohio State University.

SECTION G—BOTANY.

In accordance with arrangements previously made the section met on June 29 for the transaction of business and the dis-

cussion of the future relations of the section to the Botanical Society of America. Professor George F. Atkinson was elected secretary *pro tempore* in the absence of Professor F. E. Lloyd.

The principal feature of the meetings on the following days were the splendid excursions which had been arranged by the local committee. Adequate transportation, well-appointed lunches, and the presence of the botanists of the botanical department of Cornell University, who were familiar with the flora, made these outings a very profitable feature, and called out an attendance as large as that customarily seen at technical sessions.

On Saturday, June 30, a party of twenty-three visited the atoll moor near Chicago, eighteen miles from Ithaca. For a distance of twelve or fifteen miles on the route the glacial 'dumps' or terminal moraines were visible to the party, showing in many cases the 'kettles' or 'pot holes' or 'cat holes,' as they are variously termed, many of which support characteristic moor vegetation. The atoll moor which was first visited was the site of a former large glacial pond which is now nearly filled by the growth of vegetation, there being a deep central small pond and an outer moat containing water at the shore of the original pond.

After lunch on the west bank of the moor Professor Atkinson gave a brief talk describing the topography of the moor and outlining the different theories which have been suggested in explanation of the peculiar topography which has been formed by the vegetation filling in. Dr. Wiegand called attention to the principal species of plants and plant formations, pointing out the work of each in moor formation.

The party then explored the vegetation of the border along one side, which is made up of grasses, sedges and herbs. Here a large number of Uredineæ were found among which were five or six heterœcious species with the æcidial stage and the uredo stage growing on adjacent hosts, as pointed out by Dr. Arthur. The *Cassandra* formation, which covers the larger part of the moor inside of the moat, was then explored. In reaching this it was necessary to cross the water in the outer moat and also a narrow elevated ridge just inside of this, which for a great distance is covered by *Spiræa salicæfolia.* Among the *Cassandra* were quantities of *Sphagnum,* and many other plants lesser in number, as *Andromeda polifolia, Vaccinium macrocarpon* (cranberry), etc.

From this moor the party was led to one of the smaller and deep kettles, which contains at this season but little water. The zonal formation of the vegetation is also characteristic here: the center is a sedge and grass formation, the border an *Isoetes* formation, which at this time was partly submerged and partly on dry land. Between this and the central grass formation were partially submerged aquatic plants.

The party next drove to Malloryville moor. On one of the banks of this moor is a bed of *Pteris aquilina* (brake) which every year presents numerous cases of apospory, though the season was a little early for good examples. This moor is a high moor. The center is occupied with *Andromeda polifolia* and scattering *Cassandra,* with a deep bed of sphagnum. Pitcher plants, orchids, etc., were observed. Upon one side (south) the *Andromeda* is each year attacked by a parasitic fungus, *Exobasidium,* which causes a regular hypertrophy of the leaves. The affected shoots are colored a bright red, and the leaves instead of being thick, narrow and with inrolled edges, are thinner, broadly elliptical and flat, taking on exactly the shape of the *Cassandra* leaves, so that but for the

color it would suggest a 'bud shoot' of a *Cassandra* from an *Andromeda*. The appearance of two generic types in the branches of one shoot is very striking.

On Monday, July 2, a party of thirty-four drove to Enfield Gorge, alighting at the foot of the gorge, while the carriages were taken to the head of the gorge, a little more than two miles distant. The numerous successive falls and cascades were observed, also the geological formations, but especially the vegetation. There were numerous liverworts in the wet rock walls. In one place *Preissia* and *Conocephalus* are abundant and are usually brought into zonal formation by the different moisture conditions which vary according to the surface contour of the perpendicular rock wall. At a short distance *Pellia* usually grows where there is a greater quantity of water dripping down the rock. This year there is more moisture than usual. The dripping water is so abundant that it is killing out the *Preissia* and *Conocephalus* in certain spots and the *Pellia* is coming in and overgrowing them. These features were very easily demonstrated. Higher up on the clay bank at this place *Blasia* is abundant, and on the flat rocks below *Marchantia* was found.

Near the upper end of the gorge was an abundance of the fern, *Pellæa gracilis*, on the moist rocks. The vegetation of the small alluvial plains here and there was rich in forest and shade plants which afforded an excellent opportunity for observation of 'mosaics' and various ecological features.

The interest shown in a meeting in which the out-of-door features occupied so prominent a place suggests the desirability of their annual repetition, although it is by no means to be taken for granted that field excursions might always be organized under such favorable circumstances as those offered by Ithaca and the Cornell botanists.

D. T. MacDougal,
Chairman Section G.

SCIENTIFIC BOOKS.

Der Bau des Fixsternsystems mit besonderer Berucksichtigung der photometrischen Resultate. Von Dr. Hermann Kobold. Friedrich Vieweg und Sohn. 1906. M. 6.50.

This volume is No. 11 of a series, 'Die Wissenschaft,' whose declared purpose is to place before the public, from time to time, a digest of the progress that has been made in definite departments of scientific research. Designed alike for the instruction of the general reader and for the orientation of the professional student in his own field, Dr. Kobold's work must be regarded as upon the whole an eminently satisfactory achievement. It is, indeed, probable that competent critics will dissent vigorously from some of his conclusions and will regard as far from final his judgment upon much of the conflicting evidence marshaled in the text. But with all due reserve in these respects the book possesses great merit both as a compilation of data relative to the structure of the stellar system and as a summary of current theorizing upon that data.

In some twoscore pages there is passed in brief review the methods of determining such fundamental data as the position, brightness and color of individual stars, stellar spectra, parallaxes, proper motions and the apparent distribution of stars upon the sky. Then follows the backbone of the work, a hundred pages devoted to a critical consideration of the present state of knowledge along these several lines, with particular stress upon problems of stellar motion. The author here defends the thesis, supposed to be original with him, although recently brought into prominence by Kapteyn, that the stellar motions can no longer be regarded as lawless in their arrangement, directed in equal measure toward all parts of the celestial compass. Rather must we consider them as having a definite relation to the Milky Way, the exact nature

of that relation being a large problem for future study, while as an immediate consequence of the altered concept we have doubt cast upon the supposed determinations of the sun's motion in space. At this point, as in most discussions of the kind, we miss a frank recognition of the relativity of all motion, and its corollary that the direction and velocity of the motion to be imputed to the sun is purely a matter of convention and definition, depending upon the choice of an origin to which that motion shall be referred. The author appears to regard the solar motion as something fixed in the order of nature, which should be found always the same, barring accidental errors, from any considerable group of stars used for its determination.

To the non-professional reader, doubtless, the most interesting part of the work will be found in the third section, devoted to the construction of the heavens. Without ignoring the work of others, Easton, Kapteyn, Schiaparelli, Stratonoff, etc., Seeliger's discussion of the distribution of the Durchmusterung stars here plays the principal rôle and is described by the author as 'a complete solution of the problem'; which 'determines the universe as revealed to us in the enumeration of the stars,' etc. The character of the finite and definitely limited universe thus revealed is described as follows:

> Throughout a finite space of spherical form there are distributed bodies of widely varying mass and widely varying physical condition. Amidst gaseous nebulæ of extraordinarily low temperature are placed other bodies strongly condensed and glowing hot. The arrangement of these individual masses is not one of haphazard uniformity, but, as swarms, they are clustered about individual centers which, in loose relation one to another, are arranged in the shape of a great spiral with multiple arms. In the remoter parts of this spiral the hotter and gaseous stars predominate, while near the center of the spiral is the sun and its more closely related stars, which for the most part resemble it in physical condition. Many of these latter share in the motion of the sun along the fundamental plane of the spiral, *i. e.*, the milky way. There are also numerous other groups of stars possessing a common motion in the plane of the galaxy.

The doctrine of a demonstrably limited stellar system thus presented is avowedly based upon statistics of the distribution of stars brighter than the tenth magnitude, and as these stars constitute, both in number and extent, only a small fraction of the visible universe one is tempted to question the soundness of that logic which extends to the larger aggregate, conclusions of an empirical character derived from a minute fraction of the whole. Indeed, conservatism in this respect seems the more required, since, as is conceded by Kobold, the apparent distribution of the fainter stars is quite unlike that of those from which his conclusions are drawn. Even for these brighter stars it is probable that the supposed indication of a limited and finite system is fallacious and arises from the tacit assumption that the fainter stars appear faint only by reason of their greater distance from the earth. It has been recently shown that such is not the case, the stars of the fainter magnitudes being intrinsically less luminous than those of the brighter classes.

At page 215 of the text Dr. Kobold falls into serious error in comparing Kapteyn's empirical formula for the probable parallax of stars of determined proper motion and brightness with Comstock's determination 0.0045", as the mean parallax of a considerable group of stars of the average magnitude 10.5. According to Kobold, *'Kapteyn's Formel nur 0.0016" verlangt,'* for this group of stars, while in fact the formula furnishes for this case 0.0042", in excellent agreement with the observed value. It is only justice to Dr. Kobold to state that no other similar case has come within the reviewer's note.

G. C. C.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for August contains articles on 'Volant Adaptations in Vertebrates,' by R. S. Lull; 'External Morphology of the Dugong,' by H. Dexler and L. Freund, and 'Reproduction of *Metridium marginatum* by Fragmental Fission,' by M. L. Hammatt. Dr. Lull notes that volant evolution has occurred seventeen times, seven of these instances being for true flight. Dr.

Lull will pardon us for saying that there seems no good reason to suppose that the enormous occipital crest of Pteranodon was needed to keep the animal head to wind; were this the case it would have inevitably tripped the creature up when it wore ship. There is a slip of the pen in the statement that in birds 'The scapulæ and coracoids fuse with each other firmly,' since actual fusion only takes place in birds that do not fly, and not in all of these. The specific name of the flying frog is *reinwardtii* not *reinharti*.

We will also put a note to the quotation from Professor Moseley on page 539 and say that the dropping of the wings by the albatross is very likely for steering or balancing and that often one wing only, or the tip of one wing is dropped.

The authors of the article on the dugong note the lack of good figures of this animal, but fail to entirely remedy this defect, as the accompanying figures are few and not very good.

The Museums Journal of Great Britain for July contains the address of the president of the Museums Association, Dr. W. E. Hoyle, given at the Bristol meeting. This was devoted to 'The Education of a Curator,' is both instructive and interesting, and should be widely read. First among the qualifications of a curator Dr. Hoyle places 'general culture, tact and courtesy; an ability to suffer fools gladly.' Evidently the experience of Dr. Hoyle has been similar to that of other curators and he has our sympathy. It is interesting to note the value accorded to an acquaintance with the practical side of museum work, such as planning cases, structure of locks, cataloguing, taxidermy and the preparation of skeletons, since Dr. Hoyle has been so successful as a museum administrator that he is qualified to 'talk by the book.' Reference is made to the small salaries of museum officers, and in this respect matters are probably better in the United States than in Great Britain.

Bird Lore for July-August has articles on 'A Kingbird Family,' 'My Experience With a Blue-headed Vireo,' 'A Bit of Robin History' and 'The Yellow-breasted Chat.' W. W. Cooke contributes the seventeenth paper on 'The Migration of Warblers' and in 'The Audubon Societies' is given a summary of the laws for the protection of birds, or for the abolition of proper protection, likely to come up at the next legislative session in various states.

The Educational Leaflet, No. 21, is devoted to the scarlet tanager.

The Zoological Society Bulletin for July is termed the Reptile Number, being mainly devoted to a consideration of the more important reptiles now on exhibition. Under 'Methods of Exhibiting Reptiles' it is stated that many classes visit the park and that everything possible is done to assist them in obtaining correct information, children being taught that most snakes are harmless and encouraged to handle certain species. African reptiles are unusually well represented in the society's collections. There is a good illustration of the young two-horned African rhinoceros recently received, this being the first brought to this country in the last eight years.

The American Museum Journal for July has for its more important articles a detailed account of 'The Willamette Meteorite,' by E. O. Hovey, a notice of the commencement of work on the new west wing, and the concluding part of Mr. Chapman's 'List of Birds found within Fifty Miles of the American Museum of Natural History, New York City.' This is illustrated and accompanied by a list of the principal papers relating to the birds of the vicinity of New York City. The two parts are published together as Guide Leaflet No. 22.

The collection of woods has been embellished by the addition of copies of the leaves and flowers of the magnolias, the exhibit illustrating the life of the Plains Indians has been installed and a very perfect example of the jaws and head armature of the giant extinct fish *Dinichthys* placed on exhibition. There are many interesting notes on other work of the museum.

DISCUSSION AND CORRESPONDENCE.

THE SMITHSONIAN INSTITUTION AND THE MUSEUM IDEA.

THE discussion opened by David Fairchild and continued by David D. Mottier,[1] urging the divorce of the museum idea from the Smithsonian Institution, appears to me a hopeful sign, indicating an awakening of the scientific public to the underlying deeper question: Has the Smithsonian Institution been managed in accordance with the will of Smithson or has this country proved faithless to the trust freely accepted?

For almost half a century I have taken note of the Smithsonian Institution. I knew Joseph Henry personally quite well and in many ways assisted and was helped. I know his 'History of the Beginnings of the Institution,' which is also quite well known abroad, having been republished extensively in Europe; for example, *Cosmos*, IIe Series, T. III., Paris, 1866, pp. 723–760. The 'museum idea' is fully considered therein and everything local or even national is shown to be in conflict with the intention of Smithson.

Under the successors of Joseph Henry, the institution has gradually ceased to conform to the founder's intentions. Congress has been called upon to furnish money—and our Billion Dollar Congress has responded most liberally. A national museum has been developed, a new four-million-dollar building is now going up for the same; a zoological garden and an astrophysical observatory have been established; finally, costly experiments on flying machines have been provided for by Congress, all under the management of the secretary of the Smithsonian Institution, who is not an officer of the nation, but elected as executive officer of the Smithson Trust and paid exclusively from the Smithson fund.

It is not necessary to consider the qualifications of the successors to Joseph Henry. But it can not be denied that they were first of all *specialists*, the one in fishes, the other in stars. Thus they were not naturally predisposed for the broad object of the institution: the increase and diffusion of knowledge among men.

[1] SCIENCE, June 8 and July 27.

Furthermore, each of the new national institutions established requires the full time and energy of a first-class man; this is the experience of other countries, where such national scientific institutions have long preceded and much excel ours. It can, therefore, not be questioned: both parties, the nation and the Smithsonian, have lost heavily by the attempt to administrate and plan our national institutions at the cost of the Smithsonian Fund.

The costly national institutions have not given the nation such a return in results as the outlay entitles us to expect. The putting of all the work of many able men on the shoulders of the one secretary of the Smithsonian Institution has necessarily crippled the national institutions, while it has equally necessarily made it impossible for that officer to give thought or time to the foundation of Smithson from the funds of which he drew his salary and to which he, therefore, owes in duty both all his time and his entire energy. That both the Smithsonian and the national institutions have thus been crippled can not be denied; specially glaring instances have come to my personal knowledge and have been referred to in some of my publications.

In brief, the following are the main facts of the condition that actually confronts us:

1. Congress appropriates millions of dollars for certain national scientific institutions, located at Washington, but depends for their planning and administration on the time and ability of one single man who is not in any sense a national officer nor receiving salary from the national funds; this one man serves as well as one man can do the work really requiring a number of men, each one a specialist in the line represented by each one of these different national institutions.

2. Congress has accepted Smithson's trust and funds, and through a board of regents manages the institution of Smithson. This board elects a secretary as executive officer and pays him a salary out of the Smithson Fund. His work necessarily demands the full time and all the power of a most able man of the broadest possible education and the highest mental endowment; for Smithson demanded his institution to work 'for the in-

crease and diffusion of knowledge among men.'

The British government refused to accept this trust from the Englishman Smithson, deeming the condition too broad and too difficult to comply with. The Congress of the United States thereafter was made the same offer by Smithson on the same conditions and accepted this trust on these conditions from Smithson while he was alive; this trust we are in honor bound to meet in every particular, now that Smithson is dead.

Are we faithful to this trust when we pay the secretary of the Smithsonian Institution out of the Smithson Fund—and then compel him to administrate our own large national institutions and thereby force him to neglect the Smithsonian Institution proper? To what extent this has been done is likely soon to become known throughout the scientific world in connection with questions that have thus far been suppressed here at home, but will come out by the enforcement of a recent act of Congress.

It seems to me that it is not merely a question of 'divorcing the museum idea' from the Smithsonian Institution, but to put a stop to the robbing of the Smithson Fund and to the nullification of the Smithson will. We certainly should administer our own national museums, zoological gardens, astrophysical observatories and flying machines, all paid for from national funds, granted by Congress; we should select the best man for each one of these duties and pay him from our own United States funds for his work. To take the pay for this our work in any manner or form from the Smithson Fund is to rob the grave of Smithson. It is a national disgrace that should cease the instant it is realized to exist.

But we should not only cease to rob the grave of Smithson; we should also again make an effort to comply with his conditions and to realize, in his name, so far as it be possible, his ideal: to increase and diffuse knowledge among men throughout the world.

Let us at least try to do that as well and as faithfully as it was done under the administration of the first secretary of the Smithsonian Institution, Joseph Henry.

Gustavus D. Hinrichs.
4106 Shenandoah Avenue,
St. Louis, Mo.,
August 17, 1906.

Is not the Smithsonian an Institute of Research?

To the Editor of Science: In your issues of June 8 and July 27 I note communications from David Fairchild and David M. Mottier in regard to certain changes they would like to see made in the work of the Smithsonian Institution.

I wish to take exception to one or two statements made by these gentlemen, though I entirely agree with some of their suggestions.

In the first place, both articles *imply* that the Smithsonian Institution is not now a place where important research is being done. Surely if one will but glance over the last 'Annual Report of the Smithsonian Institution' and the last volume of the 'Proceedings of the National Museum,' some sixteen hundred pages altogether, he will be forced to the conclusion that research is being done at the Smithsonian Institution. Note also some of the important monographs that have appeared under the auspices of the Smithsonian, Dr. True's recent work on the whales, for example. As is pointed out by the assistant secretary, the time of the regular staff is largely taken up with administrative duties, but, in spite of this fact, a very considerable amount of research is accomplished by these men. Besides the investigations carried on by the regular staff of the institution a large amount of research is done under the auspices of the Smithsonian through grants of money, the loan of material from the museum, and in other ways.

It seems to me that the Smithsonian is already the 'Nucleus of a great national * * * institute of research.' That with sufficient funds much more might be accomplished goes without saying; certainly it would be well to have a permanent corps of investigators who should not be hampered with routine administrative duties, and also tables where college

men could come for a time to carry on their investigations, though how a professor could leave his college duties for a 'term of *two* years' is not evident to me.

But why give up the museum feature of the Smithsonian? Certainly the United States should not be without a national museum. And if the museum were given up, what would be done with the great collections already there, and with the magnificent building now under construction? Used simply as a research laboratory this building would accommodate all the investigators in the entire country. With such a start as has now been made it would seem a great pity to discontinue one of the most popular and instructive attractions of the national capital, and to distribute to other museums the exhibition and working collections there brought together.

In the first article noted it is stated that 'In our universities the pedagogic element is predominant to a degree quite unknown in the German universities, and the body of investigators in them in any one field is too small to create that which is the most stimulating thing in all research—an atmosphere of investigation.' It is certainly true that most of us who are in university work are heavily burdened with pedagogic duties; but President Gilman once said, 'Sterile intellects attribute their non-productiveness to overwork, when a more acute diagnosis detects a lack of will-power.' The statement in the above quotation in regard to the absence of the 'atmosphere of investigation' in American universities seems to me to be rather sweeping. Of course in a majority of our colleges the number of men in each department is so small that it is difficult to create an atmosphere of investigation, but that there is such an atmosphere in many of our best institutions is an undoubted fact.

In conclusion, I should say—let the Smithsonian *continue* to be the nucleus of a great national institute of research, and, without diminishing the importance of the museum feature, let sufficient funds be made available to carry on the additional work suggested in the two articles quoted. ALBERT M. REESE.

SYRACUSE UNIVERSITY.

SPECIAL ARTICLES.

YELLOW MICE AND GAMETIC PURITY.

THE attention of readers of SCIENCE has been directed by Professors Morgan (1905) and Wilson (1906) to the curious method of inheritance of yellow pigmentation among mice, according to observations made by Cuénot (1905). Cuénot found that yellow in mice behaves as an ordinary Mendelian character dominant over all other types of pigmentation, but peculiar in that it can never be obtained in a homozygous condition, yellow mice forming regularly two sorts of gametes, one sort being yellow, the other sort being in some cases gray, in other cases black, and in still others chocolate.

These surprising observations carry with them important theoretical conclusions. Already they have been interpreted in ways very different by Cuénot and by Morgan. A fuller knowledge of the facts may show which interpretation is correct, or whether possibly neither is adequate without some modification. It is important first fully to establish the facts. With this idea in mind (and, I confess, inclined to be sceptical because I had found yellow so different in behavior in guinea-pigs and rabbits from what Cuénot reports it to be in mice) I have recently made a reexamination of some breeding records of fancy mice, reared in 1900–1901, in connection with an investigation of sex-determining factors in mammals. The purely incidental records of color-inheritance have not previously been published, and I should hesitate to publish them now in their fragmentary condition, did they not serve to supplement and in the main to corroborate the more extensive observations of Cuénot.

My original stock of mice, obtained from a near-by breeder, consisted of the following sorts: (1) black-white spotted mice, some homozygous, some containing chocolate as a recessive character; (2) chocolate (or chocolate-white) mice, homozygous or else containing recessive total albinism; (3) yellow mice (three in number) all of a clear reddish yellow color above, but almost white below. Young were obtained from one only of the three yel-

low mice, a male (♂ C). A second male was not used in the breeding experiments. The third yellow animal, a female, was sterile by every sort of mating tried, a considerable number, which fact is of interest in connection with Cuénot's experience, to the effect that yellow mice are feeble in reproductive capacity, though vigorous and even savage. (4) The fourth category of mice consisted of a pair of *very large* albinos and their three young. Subsequent experiments showed that these albinos transmitted as latent characters in their gametes either yellow or chocolate, but in no case black pigmentation.

Other yellow mice were obtained (1) by mating the yellow male with chocolate females, (2) by mating the albinos mentioned to black animals, and (3) by mating a chocolate female with one of the albinos.

The experiments which will be described in detail relate to crosses of the yellow mice *inter se* or with mice of other colors.

Before passing to a consideration of the crosses, I should mention that the yellow mice obtained in my experiments were of two distinct types in their *adult* pelage. In their first coat all alike were of a clear yellow color, like the three original yellow mice. This character was retained in a part only of the yellow mice produced in my experiments; the others developed in their adult (second ?) coat a certain amount of chocolate pigment found associated with the yellow pigment granules, especially toward the base of the hairs. Animals of this second sort I shall call *sooty yellow*, to distinguish them from the *clear yellow* type, in the hair of which only yellow pigment is found. Sooty yellow mice are undoubtedly included in Bateson's (1903) category of 'dingy or sooty fawn' formed 'when dark pigment is present in association with predominant yellow.' Cuénot evidently had under observation both clear yellow and sooty yellow animals. He states that the yellow race contains numerous unfixable variations, not hereditary, ranging from a clear orange yellow to a sooty or grayish yellow not very different from the color of gray mice. The statement that these variations are *not hereditary* seems to me unfortunate, as seeming to imply that characters are not inherited, unless in conformity with known laws of inheritance.

The following observations corroborate Cuénot's statement that yellow is a dominant character in mice. Two clear yellow mice (♀ 3.2[a] and ♂ 3.1[c]), own brother and sister, born of a chocolate female (♀ 3) mated with the original clear yellow male (♂ C), produced, in three successive litters, 8 yellow and 2 chocolate young. The same female bore, by another clear yellow male, 2 yellow and 1 chocolate young. Accordingly her total young by mates of her own color were 10 yellow and 3 chocolate, a close approximation to the 3:1 Mendelian ratio. It is clear that chocolate was present as a recessive character in the yellow parents. Black was as certainly *not* present as a recessive character, since it is known to dominate over chocolate, when present in the same zygote with it.

Not all of the yellow young produced by these matings had the same clear yellow color as their parents. Three of them proved to be sooty yellow, on attaining their adult coat; four remained clear yellow, like the parents; and the remaining three died before attaining the second coat, so that they can not be more accurately classified.

The recessive nature of chocolate in relation to yellow is further indicated by the following matings between a chocolate and a yellow individual, the young being in all cases either chocolate or yellow in color, never black.

Parents.				Young.			
Clear Yellow.		Chocolate.		Clear Yellow.	Sooty Yellow.	Yellow, Type not Determined.	Chocolate.
♂ C	×	♀ 3	=	2			4
♂ 3.1[c]	×	♀ 3	=	1		2	2
♂ 3.1[c]	×	♀ 3.1[a]	=	1		3	4
♂ C	×	♀ 3.1[a]	=			7	3
♂ C	×	♀ 3.2[b]	=			1	2
♂ C	×	♀ 4	=		1	2	4
♀ 32	×	♂ 49	=			1	4
Totals,				4	1	16	23

The total number of yellows produced in these matings is 21, of chocolates 23. Un-

fortunately the type of the yellow young is left uncertain by my records in all except five cases. Four of the five were clear yellows and one a sooty yellow.

The three yellow animals employed in these matings, ♂ C, ♂ 3.1[c] and ♀ 32, evidently bore chocolate as a recessive character, but not black. For if black had been present as a recessive character, it should have made its appearance as an active character in half of the young produced, but not one of the 44 young recorded in this table was black pigmented. It is perfectly clear, however, from Cuénot's statement that black *may* be present in a yellow mouse as a recessive character. That statement is supported by the following observation:

A yellow female, ♀ 35, own sister to yellow ♀ 32 previously mentioned, was mated with the same chocolate male, ♂ 49, with which ♀ 32 had been mated. She produced three young, two of which were yellow pigmented, and one *black*. The difference in the gametic condition of these two sisters is readily explained. Their mother was an albino which transmitted to each of them the dominant yellow which they manifested; their father was a black animal which bore recessive the chocolate character. Evidently he transmitted black to ♀ 35, but chocolate to ♀ 32. Accordingly the gametic formula of ♀ 35 was yellow (black recessive), but that of ♀ 32 was yellow (chocolate recessive).

The chocolate male (♂ 49), like chocolate mice in general (see Allen, 1904), transmitted no pigment character other than chocolate. Mated with three different chocolate females he produced 11 young, all chocolate pigmented. He was mated likewise with three black females, each of which bore chocolate as a recessive character. These matings produced 4 black and 2 chocolate young. In no other mating, except with yellow ♀ 35, did he produce black pigmented young.

Two matings were made between an albino (bearing latent the yellow and chocolate characters) and homozygous black individuals as follows:

Albino Parent.		Black Parent.		Yellow Young.	Black Young.
♂ 2.1[a]	×	♀ 1	=	1	3
♂ 2.1[a]	×	♀ 1.3[c]	=	2	1
Totals,				3	4

The expectation is equal numbers of yellow and of black young, on the hypothesis that yellow dominates both black and chocolate and that black dominates chocolate.

Another albino, own sister to ♂ 2.1[a] and like him bearing latent the yellow and the chocolate characters, was mated with black individuals of the same family as those used in the foregoing matings but bearing chocolate as a recessive character. The result was as follows:

Albino Parent.		Black Parent.		Yellow Young.	Black Young.	Chocolate Young.
♀ 2.1[b]	×	♂ 1.1[b]	=	2		1
♀ 2.1[b]	×	♂ 1.2[b]	=	2	2	1
Totals,				4	2	2

The expectation in this case is that young of three sorts will be produced in the proportions, 2 yellow, 1 black, 1 chocolate, which is exactly realized in the totals obtained.

A mating was likewise made between an albino, ♂ A (father of the albinos ♂ 2.1[a] and ♀ 2.1[b] used in the two experiments just described, and like them bearing latent the characters yellow and chocolate) and a chocolate female ♀ 3.2[b], used also in matings with yellow ♂ C. This mating produced one yellow and one chocolate young, three other young dying before their coat pigments were developed.

These various observations harmonize entirely with the statements of Cuénot, showing that in mice the order of dominance of the three pigments of the hair is *yellow, black, chocolate,* each dominating those which follow it in the series, but being recessive in relation to those which precede it. This order is the more surprising because in rabbits and guinea-pigs black is dominant over yellow. In guinea-pigs black is dominant also over chocolate, but in rabbits a pure chocolate is unknown.

The occurrence of two distinct types of yellows is a matter deserving further attention. The sooty yellow type may evidently be hetero-

zygous, since it may be produced by a cross between yellow and chocolate (see mating ♂C × ♀4), but clear yellow may likewise be produced in the same way and may be likewise heterozygous, as is shown further by the result of mating clear yellows *inter se*. Clear yellows so mated may produce, as we have seen, both chocolate animals and those of the sooty yellow type. Whether sooty yellows may in turn produce clear yellows, my experiments do not show, but this seems highly probable. Whether these two types differ in gametic formula is at present uncertain. The few yellow animals from which I secured young were evidently all heterozygous, like the 81 yellow mice of generation F_2 tested by Cuénot. They were also clear yellow, all except one. That one, a sooty yellow female, bore a litter of three young by a black mate; two of the young were yellow and one black.

In the hair of clear yellow animals, I have found only yellow pigment granules; but in the hair of a sooty yellow which I examined, chocolate granules occur sparingly, with the yellow ones.

Yellow heterozygotes may probably also develop *black* pigment in their adult coat, when black is the recessive character present. For Dr. G. M. Allen, when studying color-inheritance under the writer's direction, obtained a pair of yellow mice, about four weeks old, from a breeder in Washington, D. C., and within a short time these animals began to develop small spots of *black* upon the back. Unfortunately Dr. Allen was soon after forced by the assumption of other duties to discontinue his experiments with the yellow type, and since that time I have been unable to secure material for further study of the matter.

Cuénot finds in his experiments that *all* yellow mice tested by him are heterozygous, like blue Andalusian fowls (Bateson, Saunders and Punnett). He believes, what seems entirely reasonable, that this is due to infertility of gametic unions between yellow and yellow. It will be a matter of interest to see whether further investigations confirm this interpretation, or whether an explanation can be found on the ground of gametic contamination, as suggested by Morgan, or of multiplicity of factors giving rise to yellow, as to the pigmentation of stocks and sweet-peas according to recent investigations of Bateson, Saunders and Punnett (1906).

In guinea-pigs, as I have elsewhere shown (1905), yellow is recessive in relation to black, yet exceptionally a yellow-coated animal may transmit black pigmentation in about half of its gametes. The black pigmentation so transmitted is always small in amount, being in reality the black constituent of a mosaic predominantly yellow in its composition. In the parent classed as yellow (but really mosaic in nature) the amount of black is extremely reduced, or black may be absent altogether from the hair, though present as peripheral skin pigment, as is frequently the case also in yellow animals when they breed entirely true. Now the small amount of black in individuals predominantly yellow may be considered an impurity, a contamination of the self-yellow character, with black. Such contamination can be brought about by cross-breeding and exists in various different degrees. For example, (1) yellow-pigmented guinea-pigs *always* possess black-pigmented eyes. (2) They may possess also black pigment in the skin of the extremities (soles of feet, ears) but not in the hair. *Cross-breeding with blacks will increase the amount of such black pigmentation in the extracted yellows.* Animals of these two types are *recessives* in relation to self black, or to a mosaic of black and yellow; they breed true among themselves.

Again, in rabbits, yellow is recessive in relation to black, but a yellow rabbit may bear black-tipped hairs on the ears and nose, indicating the presence of the black character in a greatly weakened condition. The black impurity, however, is not in a condition of recessiveness. Yellow rabbits never, in my experience, produce black ones. But two yellow rabbits may produce a brown one, that is a yellow rabbit with sooty 'peripheral' black pigmentation mixed with the yellow. These various facts are mentioned to show that yellow animals may contain traces at least of the

black character, even when yellow is recessive to black.

The assumption which underlies the explanation of color inheritance given by Cuénot, and adopted by Bateson, is that recessives *lack altogether* a certain factor necessary for the production of the dominant pigment; that albinos, for example, have one factor necessary for the production of pigment, but lack a second factor *altogether*. Now granting that two such factors exist (they may or they may not), it is perfectly certain that many albinos possess *both* of them. For albino guinea-pigs and Himalayan albino rabbits actually do form hair pigments. There is nothing *altogether absent* from them which is a necessary factor in pigment production. In such cases, what distinguishes an albino mammal from any other sort, so far as our present knowledge goes, is a peculiarity in the distribution of the pigments over the body. Albino mammals lack pigment in the eye; what pigment they form is found at the extremities of the body.

Again, white-plumaged birds do not *lack altogether* some factor necessary for pigment formation. They invariably have pigmented eyes, but commonly lack pigment in their feathers. Nevertheless, the purest strains of white fowls are proverbially prone to form a 'black feather' occasionally. Can we say that the character, black plumage, is *altogether lacking* in white fowls? It is not present as a recessive character—I speak of established races, not cross-breds. Shall we say, with Cuénot, that an occasional black feather is a variation not heritable? By no means. In the white fowl with a black feather the black character is present, *every factor* of it! Those factors were likewise present in the white-plumaged parents of the bird in question, but they functioned less actively, so that no feather may have shown the black, though pigment was formed in the eye. The hypothesis of *absent factors* is inadequate to explain the observed facts, in at least a majority of known cases. By cross-breeding and selection we can alter the proportions of the different pigments in the coat *without eliminating* any. By repeated crossing of black with yellow, in guinea-pigs, we can weaken the activity of the black, so that while black pigment is still formed all over the body, it is formed in *less amount*. The black pigment is found in greatest amount at the extremities. If the process of weakening the black pigmentation is capable of being carried to its logical conclusion (a matter still under investigation), black pigment should finally disappear except at the extremities. Again, cross-breeding albino guinea-pigs with blacks increases the amount of black pigmentation formed at the extremities by the albinos, and induces a slight pigmentation of the coat generally, as I have elsewhere shown. How far the contamination of the albinos can be carried, I am unable as yet to say.

Facts such as these are difficult to explain on the hypothesis of two or more factors separately heritable, unless we suppose further that those factors are inherited in varying degrees or amounts. Explanation is rendered still more difficult when we come to consider characters other than pigments, such, for example, as polydactylism. For this reason I have carefully avoided incorporating the terminology of the 'factor' hypothesis into my published papers on heredity, and have referred to characters as more or less completely *active*, or in some cases as *latent*, a usage in harmony with that of Tschermak (1906). Bateson, Saunders and Punnett (1906) have recently criticized this usage, but I believe time will justify present caution in the adoption of the factor hypothesis. Morgan (1905) has attempted to combine the latency idea with the factor idea, but with results not very satisfactory from either point of view.

It seems to me, rather, that we must recognize, along with the fundamental principle of unit characters in heredity, the fact that characters may exist *in varying states of activity*.

The presence of one character often *inhibits* the activity of another. When in guinea-pigs the characters black and yellow are present together, yellow is largely inhibited. If yellow is made more active by repeated crossing with homozygous yellow, black is partially in-

hibited. In mice the relation of these pigment characters is apparently reversed. If in mice black and yellow are present together, the activity of *black* is largely inhibited; *wholly* so in the first coat and sometimes in the second, though not in the eyes; *partially* so in the adult pelage of sooty yellows. We can not suppose that some *factor* of black, wholly absent in the young, has been supplied in the adult. If so, whence has it come? Nor can we suppose that any *factor* of black is absent in either of two yellow mice, which produce black offspring. Black was not *absent,* but *inhibited!* Removal of the inhibiting character, yellow, allows black to resume activity in the young. And yet we can not suppose that yellow is in mice invariably inhibiting in its action on black. For yellow pigment, as well as black, is formed in the coat of wild gray mice. And Cuénot recognizes that yellow may 'vary' to such an extent as to be very similar to the gray of wild mice. Black is inhibited (dominated) only by yellow in that peculiar state of activity which it has in self-yellow mice, or, as I have elsewhere (1905) expressed the matter, in that condition of *'relative potency'* which it has in yellow mice. It is not impossible that a black race of mice could be found (or created) in which black had sufficient potency to dominate ordinary yellow, as it does in guinea-pigs and rabbits. Or, what would amount to the same thing, a yellow strain might be formed so lacking in relative potency (inhibiting effect) that in crosses with it, black would remain fully active. I have pointed out (1905) one similar case (of partially reversed dominance) in which certain smooth guinea-pigs form gametes of such potency as to partially inhibit in their cross-bred young the usually dominant 'rough' character of the coat. That the action in question was a temporary one, one of *inhibition,* was shown by the fact that the rough character could be recovered in full intensity in generation F_2.

Bateson, Saunders and Punnett have also shown recently (1906) that white plumage in poultry, ordinarily a dominant character, may in certain strains function as a recessive. The different behavior of yellow, in relation to other pigment types, in mice and in guinea-pigs, becomes less surprising when we learn that within the same species the relative potency of a character may vary to such an extent that it functions sometimes as a dominant, sometimes as a recessive character, in crosses with the same alternative type.

In several recent papers I have pointed out the fact that the theoretical 'purity of gametes' of Mendelian inheritance does not exist. No more does the *purity of factors* exist. We can not avoid the idea of impurity of the gametes, by introducing the conception of 'factors,' for the factors are as certainly impure as the gametes.

To sum the matter up, it is certain that unit characters exist, but it is equally certain that the units are capable of modification; gametic segregation certainly occurs in some cases (Mendelian inheritance), it does not occur in others (blending inheritance); *factors* of characters certainly exist, when characters are demonstrably complex and result from the coexistence of two or more simpler ones, as, for example, a purple pigmentation due to coexistence of red and of blue chloroplastids in plants. But let us in no case introduce more factors into our hypotheses than can be shown actually to exist.

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W. E. CASTLE.

ZOOLOGICAL LABORATORY, HARVARD UNIVERSITY, July 23, 1906.

PRELIMINARY DESCRIPTION OF TWO NEW SPECIES OF THE GENUS DICERATHERIUM MARSH, FROM THE AGATE SPRING FOSSIL QUARRY.

AMONG the commoner forms obtained by field parties of the Carnegie Museum in this rich deposit of bones, which has previously been described,[1] are two new species, provisionally referred to the genus *Diceratherium*.

The fact that *Diceratherium* is found in this horizon, which has been regarded as late Tertiary (by Marsh as Pliocene) is highly interesting, and it was thought by the present writer (*l. c.*, p. 491) that it might possibly belong in the lower Miocene. The study of the new material reveals the fact that the animals here represented are apparently somewhat more modified than the Diceratheria from the John Day beds.

The geological horizon in which this quarry is situated is at the top of the Harrison beds (Dæmonelix beds of Barbour, or the upper Arikaree of Darton). This entire section, the Gering, the Monroe Creek, the Harrison and the Nebraska beds, which overlie the Oligocene, should, I think, be regarded as lower Miocene, though the Nebraska beds may possibly represent the middle Miocene.

Diceratherium niobrarensis, n. sp.

The type, No. 1,271, of this species is a well-preserved skull, with the nasals disarticulated at the fronto-nasal suture. The nasals were found in the talus below the point where the skull was obtained, and presumably belonged to it. The premaxillaries are wanting, as is also the posterior portion of the left zygomatic arch. Except P^1 and the incisors the dentition on both sides is beautifully preserved. The principal characters of the type are as follows: Skull mesaticephalic.

$$I\frac{1}{2?},\quad C\frac{0?}{0?},\quad P\frac{4}{3?},\quad M\frac{3}{3?}.$$

The brain-case is large, the occiput high, and there is a well-formed sagittal crest with a narrow and rather shallow groove in the median line. The frontals are quite broad and convex laterally. When the nasals, which undoubtedly belong to the same specimen, are placed in position, they, with the frontals and parietals, unite in displaying an antero-posterior saddle-shaped concavity on the top of the skull. Near the anterior extremity the nasals are provided with a pair of well developed horn-cores, about 24 mm. long, rugose and subtriangular in section. Anterior to the base of the horn-cores the nasals are rapidly abbreviated, terminating in a blunt point projecting forward and downward. The narial openings, the foramen magnum, and the orbits are large. The infraorbital foramen is situated above the anterior part of P^3. The zygomatic arch is rather slender. There is no large tubercle on the supra-occipital as in *Diceratherium armatum*, but there is a prominent median ridge, which continues from near the superior margin of the foramen magnum to the top of the inion. The foramen magnum is subtriangular in outline. The occipital condyles are large and well separated by a broad median notch inferiorly. The paroccipital and postglenoid processes are very prominent, and their bases almost touch one another. The posterior nares extend forward to the anterior part of M^2. As has been stated, the first premolar is unfortunately not present in the type, but another individual of the same species (No. 1,273) shows this tooth much more reduced than in *Diceratherium armatum*. All the teeth have internal and external cingula, and are otherwise quite similar to those found in the species from the John Day.

[1] *Annals of the Carnegie Museum*, Vol. III., pp. 487–494, 1906.

MEASUREMENTS.

Greatest length of skull, approximately	450
Length of skull from occipital condyle to and including P^2	370
Length of skull from occipital condyle to M^3	190
Greatest transverse diameter of skull	235
Greatest transverse diameter of brain case	130
Greatest transverse diameter of frontals	150
Greatest transverse diameter of occipital condyles	103
Greatest transverse diameter of palate	68
Vertical diameter of the orbit	60
Length of 2d, 3d and 4th premolars and the molar series	185
Antero-posterior diameter of P^2	26
Transverse diameter of P^2	29
Antero-posterior diameter of P^4	32
Transverse diameter of P^4	36
Antero-posterior diameter of M^1	39
Transverse diameter of M^1	37
Antero-posterior diameter of M^2	35
Transverse diameter of M^2	39

Diceratherium Cooki.[2]

This species is very abundantly represented in the Agate Spring quarry, and there are at present some forty or fifty skulls, jaws, and other portions of the skeleton representing it in the Carnegie Museum. Only a small portion of this material has been freed from the matrix. Preliminary observations have been made upon eight skulls, to one of which the lower jaws are attached. Of this series a specimen designated as No. 1,572 (Carnegie Museum Catalogue of Vertebrate Fossils) is selected as the type. The skull represents an animal much smaller than *D. niobrarensis*. The top of the skull is perfect, but the anterior part of the maxillaries is wanting. The premaxillaries are lost, and the base of the skull has received considerable injury. Only the first and second molars are present on the right side, while the dentition of the left side, except P^1, is present.

The principal characters of the type are as follows: Skull mesaticephalic.

$$I\frac{1}{2}, \quad C\frac{0}{0}, \quad P\frac{4}{3}, \quad M\frac{3}{3}.$$

Brain case relatively as large as, or even larger than in *Diceratherium niobrarensis*. The occiput is rather low. The inion is broad, with a wide posterior emargination. The temporal ridges are quite prominent, not uniting to form a sagittal crest, but continuing separate as far as the inion, where they join the lambdoidal crest. The frontals are broad, especially over the orbits, and are slightly convex from side to side. The nasals are each provided with a heavy, ovate, rugose horn-core near their free extremities. The nasals are very abruptly pointed in front of the horn-cores, and are at this point directed downward and slightly forward. The dorsal surface of the skull as a whole is saddle-shaped, as in *Diceratherium niobrarensis*, but the frontals in the present species are relatively considerably broader. The zygomatic arch is quite heavy, with a rugose enlargement at the posterior angle. The narial openings are large, the posterior orifice extending forward to a point opposite the line between M^1 and M^2. The foramen magnum is rather large in size. The orbit is relatively smaller than in *Diceratherium niobrarensis*. The infra-orbital foramen is placed above P^3.

The base of the skull presents some interesting features showing a wide difference from the first species which is described in this paper. Of these the most important is the complete enclosure of the ear by the post-glenoid process and the mastoid, which touch each other in a manner somewhat similar to that described in *Ceratorhinus* according to Cope.[3] Furthermore, the dentition in the present species is distinctly more specialized than in *Diceratherium niobrarensis*, so that together with the small size of the skull it shows a degree of resemblance to European forms as *Diceratherium minutum* Cuvier. The first premolar in the present species is reduced in about the same proportion as that in the species previously described. The crotchet of M^2 has nearly closed the interspace between the cross-crests, and in very old individuals it is in fact an enclosed cavity of the tooth.

Characters worthy of being noted are derived from a number of lower jaws belonging

[2] In recognition of the kindness of Mr. James H. Cook to the field parties sent out by the Carnegie Museum.

[3] *American Naturalist*, Vol. XIII., p. 771, 1879.

to this species. The more important are the minute pair of median incisors having a rounded enameled crown, seldom showing any wear, and the very heavy and outwardly flexed angle of the lower jaw. A lower jaw from the Protoceras beds, which Professor Osborn figured,[4] suggests this very heavy angle, and it would be interesting should we be able to trace the present species to *Aceratherium mitis*.

MEASUREMENTS.

Greatest length of skull	350
Length from occipital condyle to and including P^3	307
Length from occipital condyle to M^3	150
Greatest transverse diameter of skull	215
Greatest transverse diameter of brain case	107
Greatest transverse diameter of frontals	140
Transverse diameter of nasals back of horn cores	65
Transverse diameter of nasals at the horn cores	70
Transverse diameter of palate at M^3	55
Vertical diameter of the orbit	30
Antero-posterior diameter of premolars two, three and four	68
Antero-posterior diameter of the molar series	90
Antero-posterior diameter of P^2	22
Transverse diameter of P^2	23
Antero-posterior diameter of P^4	28
Transverse diameter of P^4	29
Antero-posterior diameter of M^1	34
Transverse diameter of M^1	32
Antero-posterior diameter of M^3	26
Transverse diameter of M^3	32

O. A. PETERSON.

CARNEGIE MUSEUM,
August 15, 1906.

BOTANICAL NOTES.

SOME RECENT BOTANICAL BOOKS.

SEVERAL months ago there came from the hand of Professor Coulter another book for the use of pupils in the secondary schools. That it presents the subject with accuracy and good judgment goes without saying, for when a master in a subject writes a text-book this fact alone is a guarantee of its high standing. The present work, which bears the name of 'A Text-book of Botany' (Appleton), is a new edition, or rather a rewritten form of the widely used 'Plant Studies,' which in turn was an abridgment and combination of 'Plant Relations' and 'Plant Studies.' In the preparation of the present book Professor Coulter has made use of the suggestions and criticisms of many experienced teachers, in order to more accurately adjust the presentation of the matter to the conditions found in the secondary schools. The plan of the work can be best told in the author's own words:

> In the first five chapters the structure, function and relationships of the most obvious plant organs are considered. The purpose has been to use the most easily observed material to give preliminary training in observation, and some conception of the activities of plants. The following thirteen chapters present an outline of the plant kingdom in the simplest possible form to be at all adequate. In these chapters the morphological point of view necessarily dominates, but not to the exclusion of the physiological and ecological. In this presentation of the great groups, which is also an outline of classification, there have been included special accounts of forms of economic interest; not only because such forms as well as any others may illustrate groups, but chiefly because there is a growing conviction that Botany in the schools must relate pupils to their common experiences, as well as train them in science. For the same general reason the brief chapters on plant-breeding and forestry have been introduced. The four closing chapters include a very brief account of plant associations, the most inclusive view of plants. * * * It can not be repeated too often that this book will not serve its purpose unless it is used as a supplement to the teacher, to the laboratory and to field-work.

This is certainly an admirable statement of the purpose of botany in secondary instruction. The illustrations are numerous (320) and good, and the text is clearly written. It should prove most useful in the public schools.

In Margaret Slosson's 'How Ferns Grow' (Holt) we have quite a different type of book, this being intended for the general reader instead of the public school pupil, and therefore lacking the pedagogical form of presentation. The book is a popular manual of selected species of the ferns of the eastern United States, illustrated by forty-five plates

[4] *Memoirs A. M. N. H.*, Vol. I., p. 139, 1898.

which include a larger number of figures, mostly life-size. The author's purpose has been to give especial attention to the young fern from the time its first leaves appear up to the mature plant. These stages are illustrated by numerous figures, and these are supplemented by popular descriptions. The book will be very helpful to the class of people for whom it is primarily designed, while at the same time it will be useful to the scientific botanist who will find here much exact information about young ferns that he can not find elsewhere.

Somewhat like the last is Laing and Blackwell's 'Plants of New Zealand' (Whitcombe), which is designed 'to give an account of our native plants that will be intelligible to all.' It makes no attempt to notice or describe all of the species, dealing only with the more conspicuous flowering plants, and omitting the grasses and sedges, in addition to 'certain less important orders.' The introduction of nearly sixty pages includes a general discussion of the vegetation, in which the author has packed a great deal of most interesting information, although such words as 'formation,' 'zonation,' 'succession,' 'alternation,' 'facies,' etc., are conspicuously absent. Nor do we find that much-abused and long-suffering word 'ecology,' although the book is full of what it is now the fashion to call by that name. In short, this is an entertaining and instructive account of the plants of New Zealand told by men who have sufficient mastery of the English language to be able to write with clearness and accuracy. The book reminds us of 'Minnesota Plant Life,' written by Professor MacMillan, also a master of English, though by no means wanting in ability to write most technically on occasion. There is the same careful selection of material, the clear treatment and wealth of beautiful and apt illustrations. May we not here express the hope that Messrs. Laing and Blackwell may long continue to study and write about the plants of their country, and that New Zealand botany may not have to suffer such a loss as that involved in the retirement of Professor MacMillan from active botanical work in this country. Science can not spare such men.

A STUDY OF THE COCONUT TREE.

In an interesting paper published in the *Philippine Journal of Science,* Dr. E. B. Copeland gives the preliminary results of some studies of the coconut tree which he has made, especially with reference to its water relations. Incidentally a good many interesting facts are brought out in the course of the discussion. Thus even on large trees the roots are only about a centimeter in diameter, and they spring in great numbers (on large trees as many as 8,000) from the convex or obconical base of the trunk, which itself may reach a depth of 50 centimeters. These slender roots may be 5 to 7 meters long, and are simple, or branched at right angles to the root axis. They are very strong and elastic, and attach themselves to the soil with such firmness that the tree is never uprooted. The stem may reach 80 centimeters in diameter, and is so elastic as rarely to be broken even in the fiercest storms, although the favorite habitat of the tree is the seashore where it receives the unbroken force of the tropical winds.

Careful studies of the leaf were made, especially with reference to its loss of water (transpiration). These show that older leaves (one year old) lose more water than young leaves which have just reached their full size. This result agrees with observations made by Bergen on the leaves of the myrtle (*Myrtus*) in Italy. Some rough estimates were made as to the total amount of water transpired by the tree annually, which show that for an average tree it is more than 10,000 liters. This is a remarkably large amount when we consider the rather limited leaf area exposed by the tree.

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DISPUTED VESUVIAN ERUPTIONS.

Nine eruptions of Vesuvius are commonly admitted to have occurred during the first twelve centuries of our era, the volcano afterwards remaining quiescent until the paroxysmal outburst of 1631. Two minor disturb-

ances, however, are reported during the interval of repose, one in 1306, the other about 1500, but the authorities for both are usually discredited.

The reason for regarding the alleged fourteenth-century eruption as apocryphal is that the sole author reporting it, F. Leandro Alberti,[1] after mentioning the date adds that it happened 'when Benedict IX. was pope, and Conrad II. emperor.' As this parenthetical remark fixes the period between 1033 and 1039, critics are no doubt right in assuming that the passage applies to the eruption of 1037. Besides, supposing the event actually to have occurred in 1306, it would be strange if Petrarch and Boccaccio failed to allude to it in their geographical works of the same century, when speaking of Somma and Vesuvius. References to these authors will be found in Enrico Cocchia's interesting essay on the ancient form of Vesuvius, reprinted in volume III. of his 'Saggi Filologici' (Naples, 1902).

Our only authority for an early sixteenth-century eruption is Ambrogio di Leone, a learned physician, professor of medicine at the University of Naples, afterwards a resident of Venice, close friend of Erasmus, and highly esteemed scholar and author. Of him says one of his biographers: "Visse sempre onorato dagli eruditi e da' Signori, e singolarmente da Leone X." No reason has been assigned for doubting his statement that ashes were ejected for a period of three days, covering the country about Nola, except that contemporary Neapolitan writers make no mention of the occurrence. Their silence is the less surprising, however, considering the relative unimportance of the event, and the fact that the fall of ashes was in the opposite direction from Naples. It is possible, also, that the discharge took place from the northern side of the mountain, away from the city and invisible from it, instead of from within the crater itself, which was observed in the following century to be heavily wooded.

Leone, in his 'History of Nola' (Venice, 1514), was not only the first author to discuss the etymology of the name Vesuvius, giving abundant classic references, but also the first to portray the mountain since Pompeian times. The view given is far from crude, being from the hand of the famous engraver Girolamo Mocetto, and it is noteworthy that the two summits are shown of about equal height. Later in the century we find two authors, Agricola and Francis Scot, reporting that the Somma cone overtopped Vesuvius, but their statements are at variance with the known condition of the summits prior to the great eruption of 1631. Probably the best estimate of their respective altitudes before and after this event is that given by Schmidt, in his 'Studien über Vulkane und Erdbeben,' pp. 215–218 (Leipzig, 1881).

Accepting Leone's testimony as trustworthy, though lacking in details, there are one or two circumstances connected with the eruption which deserve mention. In the first place, it is interesting to learn from contemporary documents which have been published for the first time within recent years that the disturbance was preceded by a severe earthquake, in which two hundred and sixty inhabitants of Nola lost their lives and much property was destroyed. Following is an account of the disaster, taken from the late Bartolommeo Capasso's publication of the original:[2]

A li 6 di xbre 1499 se sentio no forte terremoto a le 6 hore de la notte, dove cadero multe case et ce morse assai gente, cioè circa 24 jentil' uomini, et 236 populani; dove che fo veramento gran pietà lo vedere tante povere persune cossì crudelemente ammazzate et sepelite sotto le fabriche, huomini, femine et certe figliole, che stavano appise a lo pietto de le meschine matri, che fo no pianto uneversale ad mirare quello miserabile spettacolo. * * *

Furthermore, we learn from various independent sources that Vesuvius was not wholly inactive during the greater part of the sixteenth century. Gonsalo Fernandez de Oviedo y Valdes, who ascended the mountain in 1501,

[1] 'Descr. Ital.,' Venice, 1561, 2d ed., 1577.

[2] *Archiv. Storico Prov. Napoletane*, Ann. VII. (1884), p. 107. Also in his 'Fonti della Storia delle Provincie Napolitane,' p. 239 (Naples, 1902). This earthquake is unrecorded in scientific literature, not even in Baratta's exhaustive catalogue, 'I Terremoti d'Italia' (Turin, 1901).

observed smoke issuing from the crater, and was told that flames were sometimes visible at night. Fumeroles were seen within the crater by Stefano Pighio in 1582, by Braccini in 1612, by the physicians Magliocco and Nicola de Rubéo, and by Padre Salimbeni, all in 1619. It will also be recalled that the year 1538 is memorable for the Monte Nuovo upheaval, one of the recorded features of which was a violent radial blast, comparable in a small way, no doubt, to the frightfully destructive agency which played such a tragic part in the West Indian catastrophes, still fresh in memory. Such being the condition of things in the sixteenth century, we have every reason to regard Leone as a credible eyewitness of the eruption which he claims to have observed from Nola in 'nostra vero tempestate.'

Finally it should be said that we owe to the well-known editor of the 'Monumenta Neapolitani Ducatus' a valuable list of references to mediæval chronicles in which several early eruptions are mentioned. Capasso's revision of the dates makes some changes necessary in the accepted catalogues. Thus, reckoning the eruption of 685 as the fifth on record in history, the succeeding ones should be referred in order to the following years: 968 or 969, 999, 1007, 1037, 1139, *circa* 1500, 1631. There are no contemporary authorities for the eruptions sometimes quoted for the years 1024 (Capaccio), 1049 (Lyell, Phillips), and 1184 (Mallet).

C. R. Eastman.

SCIENTIFIC NOTES AND NEWS.

The University of Greifswald has, on the occasion of the celebration of its four hundred and fiftieth anniversary, conferred the honorary degree of doctor of philosophy on Professor William M. Davis, of Harvard University.

At the meeting of the British Medical Association, held last week at Toronto, the degree of doctor of laws was conferred by the University of Toronto as follows: Professor Thomas Clifford Allbutt; A. H. Freeland Barbour; Sir Thomas Barlow; Sir James Barr; Sir William H. Broadbent; H. W. Langley Browne, M.D., chairman of the council of the British Medical Association; George Cooper Franklin, retiring president of the association; Professor William Dobinson Halliburton; Sir Victor Horsley; Dr. Donald McAlister, president of the British Medical Council; William Julius Mickle; M. Louis Lapicque; Professor L. Aschoff, and Dr. W. J. Mayo, M.D., president of the American Medical Association.

Dr. H. Davy, of Exeter, will be president of the next meeting of the British Medical Association to be held in that city.

Dr. W. N. Shaw, director of the British Meteorological Office, has been elected an honorary member of the Austrian Society for Meteorology.

The Technological Institute of Munich has conferred the degree of doctor of technical sciences on Dr. W. H. Perkin, in connection with the recent jubilee of the coal tar color industry.

Mr. W. Eagle Clarke has been appointed keeper of the natural history collections of the Museum of Science and Art, Edinburgh, in succession to Dr. R. H. Traquair, F.R.S.

Professor F. Cavara, of Catania, has been appointed director of the Naples Botanical Garden.

Dr. F. W. T. Hunger, of Utrecht, has been appointed director of the experimental station at Salapig, Java.

Professor Pozzi has been presented with a gold medallion portrait by the sculptor Chaplain and a memorial volume of researches by his former students on the occasion of the twentieth anniversary of his work at the Broca Hospital.

The Moxon medal of the Royal College of Physicians of London has been awarded to Dr. Jonathan Hutchinson, F.R.S.

We learn from *Nature* that at the concluding meeting of the International Conference on Hybridization and Plant Breeding the Veitch gold memorial medals were presented to Mr. W. Bateson, F.R.S., the president of the conference, Professor Johannsen, Professor Wittmack and Professor Maurice

de Vilmorin, and silver-gilt Banksian medals to Miss E. R. Saunders, lecturer on botany at Newnham College, and Mr. R. H. Biffen, for eminent services rendered to scientific and practical horticulture. Professor de Vilmorin, as the representative of the Horticultural Society and the Botanical Society of France, invited the society to hold its next conference at Paris.

UNDER the direction of Mr. Whitman Cross, Mr. Albert Johannsen, of the United States Geological Survey, is making a reconnaissance this summer with Mr. Willis T. Lee in the northeastern section of New Mexico.

A RECONNAISSANCE survey of the Paleozoic rocks in Utah is being made this summer by Mr. F. B. Weeks, of the U. S. Geological Survey. This will complete Mr. Weeks's study of the Paleozoic rocks of the state, and will furnish the final data for a paper on the subject.

MR. SAMUEL SANFORD is engaged in an investigation of the underground waters of the coastal plain of Virginia for the United States Geological Survey. The developments in this important region have been very marked since the report of N. H. Darton in 1896 and the demand for information very great, especially in regard to the quality of the water and its availability for boiler and industrial purposes. To supply this complete chemical studies will be undertaken as a part of the work.

DR. LEON J. COLE, of Harvard University, has been appointed chief of the Division of Animal Breeding and Pathology in the Rhode Island Station. J. Frank Morgan, a graduate of St. Lawrence University; H. S. Hammond, of the Agricultural College, at Guelph, Canada, and W. F. Purrington, a graduate of the New Hampshire College of Agriculture and Mechanic Arts, have recently received appointments as assistant chemists at the same station.

DR. CLEMENS SCHLÜTTER, professor of geology and paleontology, at Bonn, has retired from active service.

PROFESSOR R. HEYMONS, professor of zoology in the School of Forestry at Munster, has been appointed curator in the Zoological Museum at Berlin.

THE Bradshaw lecture will be delivered at the Royal College of Physicians, London, on November 6, by Dr. Sharkey, who will take as his subject 'Rectal Alimentation'; the Fitz-Patrick lectures will be given by Dr. Norman Moore, on November 8 and 13, and will deal with the 'History of the Study of Clinical Medicine in the British Islands'; and the Horace Dobell lecture by Dr. F. W. Andrews, on November 15, will treat of the 'Evolution of the Streptococci.'

MR. E. A. MINCHIN, M.A., the recently-appointed professor of protozoology at London University, will deliver his inaugural lecture on 'The Scope and Problems of Protozoology' on November 15.

THE Berlin correspondent of the *Medical Record* states that the physicians of Berlin are much interested in the monument to be erected in memory of Virchow. The commission has given the first prize to the design of the sculptor Klimsch, which portrays a man fighting against a fabulous monster, while Virchow's portrait appears only in a medallion on the base. The medical societies have protested against this selection, and would prefer a monument showing a full-length figure of the great pathologist. The commission has resolved to reopen the question, but no decisive action has yet been taken.

ALBERT GRANNIS LANE, assistant superintendent of the Chicago city schools, formerly president and a trustee of the National Educational Association, died on August 22 at the age of sixty-five years.

SIR ALEXANDER MONCRIEFF, K.C.B., F.R.S., known for his improvements in the system of mounting heavy ordnance, has died at the age of seventy-seven years.

MR. RICHARD GLASCOTT SYMES, for many years geologist on the Geological Survey of Great Britain, died on July 27, at the age of sixty-six years.

PROFESSOR GEORGE REYET, for the past twenty-five years director of the observatory at Bordeaux, has died at the age of sixty-seven years.

Dr. P. Hauptfleisch, docent for botany in the Technological Institute at Stuttgart, has died at the age of forty-three years.

Dr. E. A. Kehrer, associate professor of chemistry at the Technical Institute at Stuttgart, has died at the age of fifty-seven years.

The Civil Service Commission announces an examination on September 26–27, 1906, to fill several vacancies in the position of analytical chemist, qualified in methods for the detection of food adulteration, at $1,200 per annum each, and one or more vacancies in the position of scientific assistant in plant pathology, at $1,000 per annum each, in the Department of Agriculture, and similar vacancies as they may occur in that department. Competitors in this examination may, if they desire, take the examination to be held on October 17–18, upon filing new applications in due time, this examination being held in view of the urgent need of eligibles with the qualifications indicated.

Mr. Albert Willcox, an insurance broker, of New York City, has bequeathed $100,000 to the National Association of the Audubon Societies for the protection of wild birds and animals. Half of the residue of the estate is, at the death of his brother, also to go to the Audubon Society and the other half to the Tuskegee Institute.

As we have already announced, the fifteenth International Congress of Americanists meets at Quebec from the tenth to the fifteenth of September. The preliminary program contains the titles of eighty-one papers that will be presented and arrangements have been made for suitable receptions and excursions. The place of meeting, the arrangements for the entertainment of members and the scientific program promise a congress of unusual interest.

At the annual meeting of the fellows of the Royal Botanic Society held on the sixteenth inst., the old members of the council were re-elected in spite of the opposition to the present administration. The debt of the society is now £34,000. The deficit last year was £975 as compared with £1,237 the preceding year. The chairman announced that the council now proposed certain additions to the by-laws (1) to the effect that at four meetings in the year fellows might propose resolutions; (2) to enable fellows to vote by proxy; and (3) to give the council the power of recommending such persons as they thought proper to be temporarily members, associates, or otherwise affiliated to the society, and of fixing the conditions of admission, privileges and payments in all such cases, provided that due regard was had to the position, rights and privileges of existing fellows and members.

Nature states that a party of French medical men is about to visit Germany for the purpose of inspecting the medical institutions of the country. Three days will be spent in Berlin, and other cities and towns visited will include Cologne, Frankfort, Leipzig, Munich, Bonn, Heidelberg and Marburg. A committee of entertainment has been formed under the presidency of Professor von Bergmann.

UNIVERSITY AND EDUCATIONAL NEWS.

Dr. William H. Hobbs, recently professor of mineralogy and petrology at the University of Wisconsin, has been appointed to the chair of geology at the University of Michigan, vacant by the death of Professor Israel C. Russell.

Dr. O. W. Richardson, of Trinity College, Cambridge, has been appointed professor of physics in Princeton University.

Dr. J. E. Wallace Wallin, instructor in philosophy at Princeton, has been appointed professor of psychology and pedagogy in the Pennsylvania Normal School at East Stroudsburg.

Mr. E. B. Hutchins, Jr., has been elected professor of chemistry at Carroll College, where a large science hall has just been erected.

Mr. Eugene F. McCampbell has been elected instructor in bacteriology at the Ohio State University.

Professor Thoinot has been appointed to the chair of legal medicine at Paris, vacant by the death of M. Bruardel.

Dr. Alfred Philippsohn, professor of geography at Bern, has been called to Halle.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 7, 1906.

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THE YORK MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE meeting of the British Association at York from the first to the eighth of August has a peculiar historical interest in that this interesting and beautiful town was the seat of the foundation of the association seventy-five years go and was the meeting place twenty-five years ago. This time the York Philosophical Society, under whose auspices the first meeting of the association was planned in 1831, was again the host.

The many points of interest in the surrounding country and in the city itself, the numerous halls and meeting places, the beautiful garden and interesting collection of the museum and the great assembly hall, all combine to make York a most attractive and suitable place for this great gathering of the best in English science. The delightful hospitality of the people of York added much to the pleasure of this particular meeting. Perhaps the most attractive of the social gatherings were garden parties given by the Archbishop of York and Mrs. Maclagan at the picturesque and historical palace at Bishopthorpe; by the Sheriff of York and Mrs. Bentley at their beautiful home at Fulford Grange, and by the Messrs. Rowntree and Company at the celebrated cocoa works, while the museum and grounds of St. Mary's Abbey were lighted up by thousands of candles on two occasions for conversazioni. At the great cathedral an organ recital and a special

service with sermon by the Bishop of Ripon, were most impressive.

In view of the anniversary nature of this meeting, it is not out of place here to repeat the aims of the British Association which were set forth seventy-five years ago by William Vernon Harcourt as follows:

> To give a stronger impulse and more systematic direction to scientific enquiry, to obtain a greater degree of national attention to the objects of science, and a removal of those disadvantages which impede its progress, and to promote the intercourse of the cultivators of science with one another and with foreign philosophers. Therefore it is that I propose to you to found an association, including all the scientific strength of Great Britain, which shall employ a short period of every year in pointing out the lines of direction in which the researchers of science should move, in indicating the particulars which most immediately demand investigation, in stating problems to be solved and data to be fixed, in assigning to every class of mind a definite task, and suggesting to its members that there is here a shore of which the surroundings should be more accurately taken, and there a line of coast along which a voyage of discovery should be made.

E. Ray Lankester, in his presidential address before a brilliant gathering of 1,800 members and guests, reviewed some of the more important advances in science which had been made during the quarter century which has elapsed since the last meeting in York, and he characterized these advances as showing a 'continuity and healthy evolution in the realm of science' rather than any revolution or inconsistency in the previous course of human thought. His address, which was somewhat disjointed because of many cuts, was based largely upon contributions from certain leaders in different branches of science, and much was lost of that spontaneity which comes from personal opinion, although made up perhaps by the thoroughness of the presentation. Particular attention was given to radium on the side of the physical sciences and to human disease and to Metchnikoff's phagocytic theory of immunity on the side of the natural sciences. Curiously enough, one of the most widely-followed branches of modern research, experimental zoology, was not even mentioned.

In this brief outline only the general trend of the scientific work of the several sections can be given. Before Section A (Mathematics and Physical Science) President Griffiths gave a review of the progress of physical science in the last twenty-five years, emphasizing the need for more accurate measurements of the elements and for improved methods in scientific education to meet the modern requirements of the vast stores of accumulated knowledge.

Interesting discussions upon the evolution of the elements, opened by Mr. Soddy, and upon the notation and use of vectors, opened by Professor Henrici, were held in the departments of general physics and pure mathematics, respectively, while at a combined meeting of the two sub-sections a more generally interesting discussion was opened by the Honorable R. J. Strutt on radioactivity and the internal structure of the earth, in which it was concluded that no radium exists in the center of the earth and can be traced to a depth of only 45 miles, which is enough to account for the heat of the earth. The discussion was carried on by Professor J. Milne, Sir William Crookes, Sir William Ramsay, Mr. Soddy, Professor J. W. Gregory, Professor Lamb, Sir George Darwin and others. Other interesting work of the section concerned Professor Milne's seismological investigations, in which the interesting theory was propounded that a valley opens and shuts, opens by day and closes by night: and still another by Professor J. Swinburne on the nature of radiation from incandescent mantles.

In Section B (Chemistry) the work was confined chiefly to economic products, to

economic problems of commerce and to problems of diet.

In Section C (Geology) the president, Mr. G. W. Lamplugh, gave an address dealing with glacial problems of England and with special attention to local Yorkshire drifts. In the sectional meetings there was a preponderance of papers dealing with local geological problems; one of more general interest by Professor J. Milne on Certain Earthquake Relationships attracted wide attention, while a general discussion on the origin of the Trias was opened by Professor T. G. Bonney and Dr. J. Lomas.

In Section D (Zoology) Mr. J. Lister took as his subject for the presidential address the Life History of the Foraminifera, in which the old question of the significance of dimorphism of the foraminifera was clearly and conclusively answered. There were two discussions before this section and one before a joint session of Sections D and K (Botany). The first, on the Protozoan Life Cycle, was opened by G. N. Calkins and discussed by Mr. Lister, Professor Marcus Hartog and Professor Hickson. The second was opened by J. E. S. Moore on the Tanganyika problem and was discussed by Professor Lankester, Dr. Coningham, Professor Pelseneer, Mr. Boulenger, Mr. Stanley Gardiner, Professor J. W. Gregory and Mr. F. S. Harmer, the general sentiment being against Dr. Moore's theory that the characteristic fauna of this African lake indicates the early connection of this lake with the sea. The third discussion, held in joint session with K, was largely attended; the subject, The Nature of Fertilization, was opened by Mr. Vernon H. Blackman with a general historical treatment of the origin and significance of maturation chromosomes, and by G. N. Calkins and Mr. L. Doncaster, the former on the Life Cycle, with special reference to Maturation, Fertilization and Parthenogenesis in Protozoa, the latter on the Maturation of Parthenogenetic Eggs. The interesting discussion following these papers was by Professor Havet, Dr. Rosenberg and Professors Johannsen, Hickson, Poulton, Hartog and Wager.

In Section E (Geography) the presidential address, by Sir George Goldie, dealt with the history of geography during the last twenty-five years and clearly showed that from pioneer work the subject of geography has developed into a science recognized in all grades of education, thus taking a larger place in the life of the nation than ever before. Interesting papers were read by Major John M. Beacom of the American Embassy, London, on Irrigation and National Prosperity in the United States, and by Mr. Clement Reid on Coast Erosion, which was followed by an animated discussion by Mr. Stanley Gardiner and Mr. John Spiller.

In Section F (Economic Science and Statistics) Professor A. L. Bowley dealt with the inadequacy of present methods in collecting statistics, with the need of better training for statisticians, with mathematical statistics, and with the problem of the unemployed. In the program four general divisions of the subject were made, viz., Transportation, Industries, Labor Questions and Miscellanies. British and American methods of transportation were compared by R. L. Wedgewood and P. Burtt, of the Northeastern Railroad, and by Professor E. R. Johnson, with particular reference to special problems of traffic-handling, gauge limits and the like. The woolen industries were considered by Professor Clapham, Local Yorkshire Industries by Mr. J. Backhouse and Mr. Turnbull, while a discussion on the question of the Unemployed was well attended. The most generally interesting of the miscellaneous subjects were those of Mr. Lees

Smith on the Minimum Wage Policy; by Professor Edgeworth on Distribution; and by Dr. Cannon on Public Finance.

Dr. Ewing's presidential address before Section G (Engineering) dealt with the molecular structure of metals, with especial reference to their reactions under strains and to the conception that they are aggregates of crystals. He considered the matter of fatigue in metals, their recovery by rest, and the manner in which they break down under repeated alterations of stress. A long and varied sectional program of some twenty-three papers followed, many of special or local interest, some of more general value, such as Modern Armor and its Attack, by Major W. E. Edwards, and some Recent Developments in the Steam Turbine, by Mr. Gerald Stoney. Several excursions to neighboring engineering plants were made by the members of this section.

One of the most popular sections in point of attendance and of general interest was H (Anthropology). The general bearing of the president's address by Professor Sidney Hartland was the Origin and Early Relation of Magic and Religion. Many of the sectional papers dealt in a popular way with travels and peoples, customs and traditions. Amongst these one of the most interesting was by Dr. A. C. Haddon on The Ethnology of South Africa. Similar papers on special topics were numerous.

In Section I (Physiology) Professor Gotch criticized the view of vitalism in modern biology and attempted to show that physiological processes might all be interpreted in complex physical and chemical terms. The conception was advanced that the nervous system acts as a purely automatic mechanism based upon physico-chemical changes. One of the most interesting and most important discussions of the meeting was opened by Professor T. D. Acland on the Physiological Value of Rest. It was discussed, together with a paper on the neuron theory given by Dr. Bevan Lewis, by Professors Sherrington and Myers, and Drs. McDougal and Rivers. It was in this section, too, that perhaps the most acrimonious discussion took place over a paper by Dr. Hime on The Insufficiency of Preventive Measures against Infectious Disease. His view that isolation is unnecessary in infectious diseases was especially provocative and met with some sharp rejoinders.

In Section K (Botany) President F. W. Oliver gave a somewhat technical address on The Seed—A Chapter in Evolution. The papers at the sectional meetings were all of a technical nature, one discussion being held, as already noted, in conjunction with Section D.

Finally, in Section L (Education) Professor M. E. Sadler pointed out in his presidential address the fact that education is becoming more and more a national problem. He showed that the interdependence of the various parts of education is becoming more fully realized and that the different branches are tending towards greater unity. It was also shown that more definite needs were apparent in regard to individual instruction, especially as concerns the obligations to the state. As usual with this section, the program was drawn up with respect to a central topic. This year the topic selected was The Balance of Subjects in the Curricula of Schools of All Grades. The discussions on Primary Grade Teaching, on Nature Study, on Leisure Pursuits, etc., were animated and suggestive. 'Health in Schools' was presented by Professor Sherrington; Physical Training, Training for Work People, School Training for Home Duties of Women, etc., were all discussed. The

section held a joint meeting with Section A, in which the teaching of mechanics by experiment was discussed.

As usual at these association meetings there were some evening lectures on more general topics. A most interesting lecture on Volcanoes was given by Mr. Tempest Anderson, of York; another was on the manufacture of light, by Professor Sylvanus Thompson, and another on The Electrical Signs of Life and their Abolition by Chloroform, by Dr. A. W. Waller.

In 1907 the association meeting will be held in Leicester; in 1908, in Dublin; and in 1909 in Winnipeg, Canada.

GARY N. CALKINS.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. SECTION F—ZOOLOGY.

SECTION F at the Ithaca meeting held joint sessions for the reading of papers with the American Microscopical Society, June 29 and 30. The following papers were read under the auspices of Section F.

Chromosome Relations in the Spermatocytes of Oniscus: M. LOUISE NICHOLS, University of Pennsylvania.

In the equatorial plate of the first maturation division, chromosomes differing from each other in shape may be discovered. They are of three kinds: First, straight or dumb-bell-shaped, in which the halves of the bivalent chromosome lie end to end; second, curved or crescent-shaped, in which the halves lie end to end but with the extremities curved toward each other; third, a form in which the halves lie side by side. In each type a split may be seen running the length of the individual chromosome and the first division is reductional. In the prophases of the first maturation division chromosomes of the first and second types are present as straight or curved rods; the third type is represented frequently by rings, complete or nearly so, occasionally by V-shaped structures. The reduced number of chromosomes, as far as could be determined, is sixteen. Of this number, two have the ring form in the prophase, two the crescent form, while the remainder are straight or dumb-bell shaped. The chromosomes vary somewhat in size, but the differences are not strikingly great. The largest have the ring form, the smallest are straight. A tendency to localization in the nucleus is observable. The ring forms usually lie on opposite sides of the nucleus, separated by a crescent. Similarly the crescent forms lie on opposite sides with a ring between.

Notes on the Poison Organs in Fishes: H. D. REED, Cornell University.

Axillary poison glands are found in all species of *Noturus* and *Schilbeodes*. In *S. gyrinus* and *S. nocturnus* poison glands are found enveloping the pectoral and dorsal spines. Wherever found these glands are invaginations of the skin, in which respect, as well as in structure, they are identical with the poison organs of the weever fishes.

Exhibition of Bird Drawings: L. A. FUERTES, Ithaca, N. Y.

Exhibition of and Remarks upon Certain Rare or Unique Specimens in the Cornell University Museum of Neurology and Vertebrate Zoology: BURT G. WILDER, Cornell University.

Among the specimens are the smallest recorded manatee fetus; a human embryo about 4 mm. long attached to the vitellus; an embryo shark with undivided cerebrum; the brain of the anguin, or frilled shark, presenting the indifferent relation of the cerebral and olfactory portions more nearly than in any other known vertebrate; the brain of *Ceratodus*, presenting the characteristic dipnoan ventral cerebral extensions; the brains of *Tarsius, Cheiromys*

and all the anthropoid apes; the brain of the manatee; the brain of a sheep with defective callosum and fornix, and that of a cat lacking these parts altogether; that of a child born at term with the cerebral hemispheres in the fetal condition of large cavities and thin parietes; an adult human brain with an extra precommissure; the brains of two philosophers and mathematicians differing markedly, and that of a mulatto resembling one of the former; the brain of a dentist presenting two self-inflicted pistol-ball wounds; the separable dental laminæ of a young elephant; mastodon teeth and bones from near Ithaca; the brains of some rare Japanese sharks.

Sex Differentiation in Dinophilus: EDWIN G. CONKLIN, University of Pennsylvania, Philadelphia.

Korschelt (1882) discovered that *Dinophilus apatris* lays two kinds of eggs, the one three times the diameter of the other; and he further determined the important fact that the small eggs invariably develop into males and the large ones into females. He did not, however, study the oogenesis of these two kinds of eggs. The occurrence some years ago of a related species of *Dinophilus* in the marine aquaria at the University of Pennsylvania gave me an opportunity to study this problem.

The earliest stages in the developing ovary of *Dinophilus* which I have examined shows only one kind of primitive egg cells or oogonia. These cells are very small and details of their structure are not readily made out, but all are approximately of the same size. The size and structure of these cells and of their nuclei are apparently the same in all cases. I have repeatedly seen the last oogonial division, but the chromosomes are so small and numerous (about 20) that it has not been possible to distinguish any constant difference either in the number or in the shapes of these chromosomes.

After the oogonia have entered upon the growth period and have reached about twice their original diameter they begin to fuse together and in this process at least twenty-five or thirty fuse to form the female eggs, while a much smaller number fuse to form the male eggs, a fact recently reported by R. Hertwig (1905). In the fusion, the cell boundaries first disappear and then some time later the nuclear membranes dissolve and the nuclear contents are scattered in the cell, where they slowly dissolve. Only one nucleus remains in the syncytium; this is in most cases centrally placed, but I have been unable to determine whether its survival depends upon its position or upon some intrinsic difference.

In the fully formed ovarian eggs the nucleus of the small eggs is relatively larger than that of the large ones, as R. Hertwig (1905) has stated, the relative diameter of the nucleus to the entire cell being about 1:4 in the case of the male eggs and about 1:6 in the case of the female eggs. In this fact Hertwig thinks we have the cause of sex determination. It is doubtful whether this can be accepted as a general explanation, and even in the case of *Dinophilus* it is not certain that it is the true explanation. The relatively greater size of the nucleus in the male eggs is probably due to the smaller number of cells which fuse to form the cell body, and this may result from the relative isolation of the male eggs as compared with the crowding of the female eggs.

In the first maturation division the chromosomes, though small, may be counted, and it is found that there are ten in both male and female eggs. No differences in the size of individual chromosomes can be detected in the two kinds of eggs.

The manner in which the primary oocytes

fuse together to give rise to the male or female eggs suggests that the position of the eggs in the ovary and their relative isolation or crowding may here be the sex-determining factor.

Glycogen in the Nervous Tissue of Embryo Mammals, with Demonstration: SIMON H. GAGE, Cornell University.

From the first discovery of glycogen in animal tissues by Claude Bernard in the fifties until the present time, all investigators assert that glycogen is not present in nervous tissue at any stage of development or during any state of activity. In the summer of 1904 while at the Bermuda Biological Station *Amphioxus* material was fixed in absolute alcohol for the determination of glycogen. Abundant glycogen was found in the large nerve cells of the central nervous system in both *Amphioxus* and *Asymmetron*. From this discovery it was believed that glycogen would probably be found in the nervous tissues of mammals if they were taken at the right time. A series of pig embryos from 7 to 70 mm. were sectioned and plentiful glycogen was found in the cells of the dorsal ganglia in embryos from 7 to 20 mm. In the 20 mm. embryo glycogen was also present in the developing nerve trunks, and in older embryos it nearly or quite disappeared from the ganglion cells but became exceedingly abundant in the nerve trunks. These facts point to the conclusion that at some period in the growth of nervous tissue glycogen plays as important a part as in the other tissues of the body.

The Notochord of the Head in Human Embryos of the Third to the Twelfth Week, and Comparisons with Other Vertebrates: SUSANNA PHELPS GAGE, Ithaca, N. Y.

In the Cornell collection are many sagittal series which are especially favorable for the study of a mesal organ like the notochord. In a human specimen of sixty days the relations of the notochord to the cartilaginous base of the skull and the epithelium of the mouth are clear. On emerging from the axis, it forms a knotted protuberance dorsal of the base of the skull, passes diagonally through it to a pocket from the roof of the mouth, thence cephalad to come in contact with two other mouth pockets, thence diagonally dorsal through the base of the skull, again forming a knot and turning sharply ventrad, ending near the hypophysis but within the cartilage.

The same relations exist in a specimen of forty-eight days in which the base of the skull is not as far from the roof of the mouth and the excursion of the notochord is not so far ventrad.

At thirty-six days the condensed mesoderm foreshadows the skull, and the same general relations occur, the ventral excursion of the notochord being very limited and touching the straight roof of the mouth in three or four loops.

At twenty-eight and twenty-one days the notochord lies directly in contact with the epithelium of the roof of the mouth, thus showing the beginning of the history. Transections verify the above observations.

The comparative study of pig, sheep, calf, mouse, cat, chick, amblystoma, frog, shark and lamprey shows that the notochord after the earliest stages is usually completely separated from the roof of the mouth, being included in the more condensed tissue forming the skull and taking a straight course. In the pig, however, about twenty per cent. were similar to man, being in contact with mouth pockets.

In the calf, contrary to the observation of Froriep, the specimen examined showed the usual straight form.

The cephalic tip of the notochord in the

above mentioned examples varies in relation, being in contact with: (*a*) the hypophysis (ingrowth of skin); (*b*) Sessel's pocket (outgrowth of enteron); or (*c*) the first mesodermic head cavity (derivative from enteron). The last condition, found in shark, may be the typical one.

Importations of the Gipsy Moth and Brown-tail Moth Parasites from Europe: L. O. Howard, U. S. Department of Agriculture.

In the late spring of 1905 the state of Massachusetts appropriated ten thousand dollars a year, for three years, to be expended in an effort to import into the United States the European parasites of the two destructive insects mentioned in the title. The larger part of this appropriation, together with a small appropriation of twenty-five hundred dollars, made by the general government, was used and is being used in this attempt, the whole European end of the effort having been placed under the control of the speaker.

In June, 1905, he visited Europe, landing at Naples on the fifteenth of that month. At the time, the south European brown-tail moths had all issued, and the gipsy moth was in the full-grown caterpillar stage. Arrangements were made with experts in Italy, in Austria, in Hungary, in South Germany, Switzerland and France to send to Boston full-grown larvæ and pupæ of the gipsy moth; and full instructions were given as to methods of shipment. During the following summer months very many specimens were received in Boston and were cared for in a temporary laboratory at Malden and a number of different species of parasites issued, the most promising ones being tachina flies. These over-wintered successfully in Massachusetts, and a certain proportion of flies issued from the over-wintering puparia the present spring.

In April, 1906, the same journey was practically repeated, the speaker visiting first France, then Italy, then Austria and Hungary, and afterwards Germany and Switzerland, and arrangements were made, at an earlier period in the season, so that much larger quantities of both species will be secured. Shipments from many points in Europe are already being received and many parasites are being bred from European specimens of both species.

The most interesting feature of the effort so far has come through the wholesale introduction of the over-wintering nests of the brown-tail moth. On the strength of an unpublished observation of Jablonowski, of Budapest, mentioned to the speaker in July, 1905, no less than one hundred and eighty-five thousand nests were imported into Massachusetts from forty different localities in Europe, ranging from Rennes on the northwest to Budapest on the southeast. From these nests were bred the present spring and early summer many thousands of specimens of parasites of different groups; these have been colonized in the open and in out-door cages constructed of wire gauze and placed over good-sized trees thoroughly infested with both gipsy moth and brown-tail moth larvas.

The interesting feature of the experiment is the large scale upon which it has been conducted. Earlier attempts to introduce and acclimatize beneficial species from one part of the world into another have been done on a small scale; but comparatively few have been imported at any one time. In this instance the experiment was so perfectly safe and the country into which the forms were introduced was so extensively ravished by the insects that the introduction of additional pests of the same species could possibly do no harm; whereas, by such wholesale introduction, vastly greater numbers of the parasites would be

secured, thus promising earlier relief than by the other method.

On the Connections of the Funicular Nuclei of the Brains of Fishes: C. JUDSON HERRICK, Denison University.

In those teleosts which possess elaborately developed taste bud systems in the outer skin, we find that the entire taste bud system of nerves, including nerves from sense organs in the mouth and pharynx and also from similar organs in the outer skin, is very intimately connected with the viscero-motor nervous apparatus, as was to have been expected. But the terminal nuclei of the nerves from taste buds in the outer skin, which unquestionably belong morphologically to the visceral sensory system, have extensive additional sensory connections with distant motor centers of the somatic type. These long reflex gustatory paths are of relatively recent phylogenetic origin and in some teleosts are very elaborately developed. The connections in the mid-brain of the ascending secondary gustatory path I have described in a previous communication. In this paper I have analyzed the descending secondary gustatory path and found that in its further course and connections in the funicular nucleus region it has all of the functional characteristics of a somatic reflex arc—from cutaneous organs of taste to somatic muscles. This is a point of considerable theoretical interest as a concrete illustration of the way in which the most rigid morphological lines may be crossed by the exigencies of functional adaptation.

The Hackled Band in the Webs of Certain Spiders: J. H. COMSTOCK, Cornell University.

It is well known that those spiders which possess a cribellum and a calamistrum spin two kinds of silk: one, a simple smooth thread of the ordinary type, and another that presents a curled appearance. Photomicrographs of the silk of representatives of three families of cribellate spiders were presented. In each the characteristic silk consists of a ribbon-like structure which, on account of the manner in which it is made, may be termed the hackled band. In each case the hackled band consists of two elements: a series of longitudinal threads, which may be termed the warp, and a sheet of viscid silk supported by the warp, which may be termed the woof. In the hackled band of *Uloborus* and *Hyptiotes* the warp consists of two straight threads, and the woof of an exceedingly regular series of overlapping lobes. In the hackled band of *Amaurobius* the warp consists of four threads. Two of these lie in the central portion of the band; they are straight and parallel. The other threads extend, one along the middle of each lateral half of the band, and are curled. These four threads support a sheet of viscid silk, the woof. The woof has a wavy outline, but does not consist of a regular series of lobes, as in the Uloboridæ. In the hackled band of *Filistata* there are four kinds of silk. First, a double supporting line; second, the primary looped threads; third, the secondary looped threads; fourth, the woof of viscid silk.

The Divided Eyes of Blepharocera tenuipes Walker: WM. A. RILEY, Cornell University.

The physiology of the divided eyes of *Blepharocera tenuipes* has been discussed by Kellogg, but aside from incidental mention nothing concerning their morphology has been published. The facets of the dorsal eye average forty microns in diameter, those of the lateral eye twenty-four microns. Both eyes are clothed with hairs, usually one at each facet angle, rarely two. In section the dorsal ommatidia are about three times the length of the lateral. Un-

like other nematocerous diptera studied, the eyes—both dorsal and lateral—are of the pseudocone type. Among the numerous slender secondary pigment cells may occasionally be found a much-reduced trichogen cell. There is no special corneal hypodermis such as is present in Crustacea and Collembola, but it is represented by the primary pigment cells. The presence of abundant pigment between the ommatidia and the position of the visual rods preclude the formation of superimposed images. There is no evidence of pigment migration dependent upon intensity of light. In the youngest pupæ studied the eye is represented by a one-layered hypodermis in which groups of enlarged sensory cells are separated by more slender cells. There is no invagination, but the groups of sensory cells become bud-like, pushing the pseudocone cells and the primary pigment cells to their distal surfaces while the secondary pigment cells become crowded into wedge-shaped masses at either end. In course of further growth the elements elongate greatly. The lateral eye differentiates more rapidly than the dorsal, a condition to be explained by the late phylogenetic appearance of the dorsal eye.

The Nervous System and Nephridia of Dinophilus: J. A. Nelson, Cornell University.

The nervous system exhibits an embryonic condition, consisting of a brain in close contact with the hypodermis, and a pair of lateral nerve cords, connected by transverse commissures arranged metamerically. Ganglion cells, lying within the hypodermis, accompany the lateral nerve cords, and are arranged to form five pairs of ganglia. A preoral commissure connects the circumœsophageal commissures. The nephridia number five pairs, and are arranged metamerically. Those of the posterior four pairs are simple, and similar to those of annelid larvæ, terminating blindly at their inner ends. Those of the first pair are much more complex, each exhibiting two curious canalar plexuses. The whole anatomy indicates close relationship to the annelids.

Early Stages in the Development of the Salivary Glands in Sheep and Pig Embryos: Wm. C. Thro, Cornell University.

Glands in Sheep Embryos.—In an embryo 17.5 mm. long all the glands are present. The submaxillary is the most advanced, since a few side buds project from the body of the gland. The sublingual consists of a short ridge-like projection of the epithelium lining the mouth-cavity. In a 20 mm. embryo the sublingual consists of a solid cord of cells attached by its cephalic end to the epithelium lining the mouth-cavity and running caudad a short distance beneath the epithelium. In a 26 mm. embryo Wharton's duct possesses a lumen. In a 43 mm. embryo the sublingual and parotid have lumina. In an embryo 44.5 mm. long the ducts of the submaxillary and sublingual run side by side and open beneath the tip of the tongue, cephalad of the frenum.

Glands in Pig Embryos.—In an embryo 15 mm. long, head-breech measurement, the very earliest stages of the parotid and retrolingual glands are found, while the submaxillary is represented by a well-developed bud with enlarged extremity.

The Development and Relations of the Columella in the Amphibia: B. F. Kingsbury, Cornell University.

The Inheritance of Characteristics in Poultry: C. B. Davenport, Carnegie Institution of Washington.

In how far are the characteristics of organisms immutable units, incapable of modification, even when pitted against each other in pairs, as occurs in hybridiza-

tion of individuals having opposed characteristics? If the characteristics typically blend in the hybrid offspring, the theory of unit characters loses its main support; but if they typically do not blend, but reappear in the hybrid offspring, each in its pristine purity, then the theory of unit characters is supported and its corollary—evolution by mutation—follows. Hybridization of poultry shows that most characteristics do not blend and do reappear in subsequent hybrid progeny almost unaltered—*almost*, but not quite.

The Egg-laying of Chironomus annularis: JAMES G. NEEDHAM, Lake Forest, Ill.

Chironomus annularis, one of the larger midges of wide distribution in Europe and North America, occurs in the campus pond at Lake Forest College, where in May a number of new observations were made as to its manner of oviposition. The eggs are extruded while the female is hanging up among the leaves of the sedges at the water's edge. There occurs a preliminary flight back and forth across the water lasting fifteen to twenty minutes. This flight ends well in-shore, where the female settles and releases the egg masses upon the surface. The egg mass gradually settles beneath the surface, but remains attached to a little transparent float by a slender adhesive gelatinous thread which stretches out to a length of about six inches. The mass then drifts until this suspensory thread comes in contact with some submerged sedge leaf or other solid support, where it remains until hatched. It contains about 1,800 eggs, which hatch in about three days.

Some Notes on the Breeding Habits of our Ithaca Anura: A. H. WRIGHT, Cornell University.

Of the eight local anura, there have been identified the eggs of all in the field and of six in captivity. The mating embrace has been photographed with all excepting *Rana catesbiana*.

C. JUDSON HERRICK,
Secretary.

SCIENTIFIC BOOKS.

Applied Sociology. By LESTER F. WARD. Boston, Ginn and Co. 1906.

The clearness, brilliancy and vigorous defense of some pronounced doctrine which we have learned to expect from Professor Ward are characteristic of this book. It concerns real facts, not verbal distinctions; it delights by its cleverness of thought and style; it attempts to rehabilitate a particularly unpromising form of the Leibnitzian theory that proper education can create a millennium.

Very briefly, the argument of the book is as follows: The welfare of people in general (whom I understand the sociologists to mean by the perilous word society) is improvable by the control of inanimate and animate nature, including people themselves, by reason guided by science and ruled by justice. Justice means the satisfaction of every one's wants, so far as they are not outweighed by others' wants. There is reasoning capacity enough in all classes of society. Nature then does not to any degree worthy of consideration limit this control; the cause of weal and woe lies in nurture. The particular error of nurture which people should now reform is the inequality of knowledge; the many suffer because they are ignorant. The equalization of intellect will make happiness for all and will multiply a hundredfold the men and women whose eminent achievements in the sciences and arts free life from undesired labor, fear or sickness and add to it noble impulses and the means to realize them. The equalization of intellect will be secured by giving all knowledge to all men through a proper system of public education.

That the present misery of people in general is due largely to the unequal distribution of knowledge is assumed with little or no discussion of evidence or of the contrary hypothesis that one or two supermen who should next week find cures for cancer, gout and

asthma and an antitoxin against envy, worry and aimless fear, would advance the welfare of people in general more than a year's added schooling to a million of us.

The proposition that nature's limitations need not be considered by the reformer of society divides into two. The first is that though there are among individuals great differences by original nature in the capacity to reason and the capacity to acquire knowledge, there are by original nature no class differences. The evidence offered is an appeal to common experience. In fairness, Professor Ward ought perhaps to have stated that if any class, for instance teachers of science, are selected on the basis of a high standing in these capacities, his statement must soon become erroneous, additionally so if they select wives on the same basis. He has in mind chiefly the classes due to the selective action of interest in and ability to get wealth. In such cases it is hard to disprove his claim, though it would be much harder to prove it. The second division of his general proposition is that which men and how many shall be men of genius whose achievements can be transformed into the improvement of people in general is decided not by the gifts of nature, but by the conditions of nurture, the conditions being the advantages of education. His evidence for this is first a number of facts showing a certain probability that there are a hundred or more men of native ability enough to do the work of genius which only one man in fact now does, and, second, a rehearsal of the results of Odin's 'La Genèse des Grands Hommes,' which proves that the literary men of France have been born most frequently in châteaux and cities offering educational advantages. He somewhat naïvely takes Odin's facts to mean that 'genius is in things, not men,' disregarding the obvious certainty that if the achievements of men were due to original nature determined by immediate ancestry, we should still find men of achievement born in such cities, because of the certainty that such select and retain those likely on the Galtonian hypothesis to be the ancestors of men of ability. The very high probability of the birth of a man of ability in a château is perhaps more readily explained by the fact that men of ability come to own châteaux than by any very great educational advantages possessed by these rural homes of aristocracy. Odin's research in fact leaves the whole question of nature *versus* nurture where it was before. The appropriate data are records of children of known differences of ancestry under similar conditions of nurture and of children of known similarities of ancestry under different conditions of nurture. Data of the first sort, so far as obtained, contradict the author's view. Data of the second sort could be obtained without great difficulty in a comparison of the achievements of immigrants' sons brought up till, say, fourteen in a Russian Ghetto with their brothers brought up in the New York City schools.

Proof that education decides which ones or how many shall be leaders in achievement is really not so important to Professor Ward's general plea for 'all knowledge for all men' as it seems to be in his pages. There are, of course, two ways of viewing a man's achievement, as to its absolute amount and as to its amount in comparison with the achievements of his contemporaries. The former quality is the one of importance to people in general; the latter is the one by which a man gains eminence. No one doubts that the former is due largely to the environment; with the backing of a modern education I may make a discovery which Aristotle could never have made. The latter may be due almost entirely to the gifts of original nature and these may deny the world more than one Aristotle a century, and still the value of universal and advanced education may be extreme. The one failure in clearness of this volume is its failure to distinguish between absolute and relative achievement and to assign the proper social value to each. Professor Ward seems to think that a great desideratum is the elevation of several thousands a generation from mediocrity to eminence, but one is tempted to believe that his real faith is in absolute achievement and that he courageously makes an attack upon the Galtonian hypothesis because he misconceives it to limit absolute as well as relative achievement.

One may even abandon hope of and desire for the equalization of intellect and still keep the essence of Professor Ward's optimism. For every one of the desirable consequences of the equalization of intellect may be gained as well, if not better, by the same amount of effort and wisdom directed toward its *increase*. Space is lacking for me to defend this somewhat rash amendment, which the author would probably repudiate.

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Geometrische Kristallographie. By ERNST SOMMERFELDT, Privatdocent an der Universität. Tübingen. Pp. vi + 139, 31 plates and 69 text figures. Leipzig, W. Engelmann. 1906.

This is a book intended for advanced students of crystallography, written from the standpoint of the mathematician. Specifically limiting himself to the purely geometrical properties of crystal solids, the author develops his theme from the definitions of symmetry and in the first chapters defines the thirty-two recognized classes of crystals distinguished by varying grades of symmetry. These groups are variously classified and admirably illustrated by the plates which give for each of the classes the possible crystal forms and show very graphically the relations between them. In the following chapters the mathematical relations existing between the faces of the crystal are deduced and the fundamental crystallographic laws are stated. The mathematical processes, particularly vector analysis and the properties of determinants, which are chiefly involved are made the subject of a special chapter and their treatment is stated by the author to be original and to have an interest quite aside from the application to the problems of this work.

To the student actually engaged in the measurement and study of crystals the book offers little of practical interest except in the presentation of formulæ for the transformation of indices and axes which are here developed in very general form.

CHARLES PALACHE.

SCIENTIFIC JOURNALS AND ARTICLES.

THE contents of the *American Journal of Science* for September are as follows:

R. A. DALY: 'Abyssal Igneous Injection as a Causal Condition and as an Effect of Mountain-building.'

W. E. FORD: 'Some Interesting Beryl Crystals and their Associations.'

F. E. WRIGHT: 'Schistosity by Crystallization: A Qualitative Proof.'

M. R. CAMPBELL: 'Fractured Bowlders in Conglomerate.'

E. L. FURLONG: 'Exploration of Samwel Cave.'

T. L. WATSON: 'Occurrences of Unakite in a New Locality in Virginia.'

E. H. SELLARDS: 'Types of Permian Insects.'

R. H. ASHLEY: 'Analysis of Dithionic Acid and the Dithionates.'

The American Journal of Anatomy, Vol. V., No. 4, September 1, 1906, contains the following articles:

R. B. BEAN: 'Some Racial Peculiarities of the Negro Brain.' (With 8 tables, 16 figures and 12 charts.)

F. P. MALL: 'On Ossification Centers in Human Embryos.' (With 6 tables and 6 figures.)

J. L. BREMER: 'Description of a 4 mm. Human Embryo.' (With 16 figures.)

CHARLES R. STOCKARD: 'The Development of the Mouth and Gills in Bdellostoma.' (With 36 figures.)

THE July number of the *Journal of Mathematics* contains the following articles:

EDWARD KASNER: 'The Geometry of Differential Elements of the Second Order with respect to the Group of all Point Transformations.'

F. J. B. CORDEIRO: 'Gyroscopes and Cyclones.'

W. A. MANNING: 'On the Primitive Groups of Class Ten.'

VIRGIL SNYDER: 'On Certain Unicursal Twisted Curves.'

HENRY LIVINGSTON COAR: 'Functions of Three Real Independent Variables.'

DISCUSSION AND CORRESPONDENCE.

THE NATURE AND ORIGIN OF VOLCANIC HEAT.

IN SCIENCE for August 10 Dr. Elihu Thomson gives a theory of volcanic energy which he correctly describes as an extension of the ideas of Mallet. Having been recently much occupied with the theory of volcanoes in con-

nection with the larger problem of the cause of earthquakes, the formation of mountains and other phenomena connected with the physics of the earth, the discussion of Dr. Thomson has interested me, but I find it difficult to believe that either Mallet's original view or this ingeniously modified form of it is well founded. Dr. Thomson says: "A truly solid interior seems to be demanded by the accepted great rigidity of the body of the earth * * *." This view is very frequently expressed, but in my recent paper, 'Researches on the Rigidity of the Heavenly Bodies,' published in the *Astronomische Nachrichten,* No. 4104, July 10, 1906, it seems to be proved clearly and directly that the rigidity of the earth is not inconsistent with a fluid interior. And in another paper, not yet published, I think I have proved conclusively that a fluid substratum underlies the earth's crust. Accordingly, although I am an astronomer, and have shown in the paper above cited that the rigidity of the earth exceeds that of steel, and perhaps closely approaches that of nickel steel used in armor plate, it seems to me that geologists have adopted a mistaken course in conceding the solidity of the earth demanded by astronomers, for two reasons: (1) Rigidity does not really disprove internal fluidity; (2) the geological evidence of the existence of a fluid substratum is overwhelming, and this latter result is confirmed by my unpublished investigation on the cause of earthquakes.

In my paper on the rigidity of the heavenly bodies, above cited, the argument respecting the internal state of the earth is expressed as follows:

> It is, perhaps, worth pointing out that as a molten earth, in which the density follows Laplace's law, would have a mean rigidity of its layers equal to that of wrought iron, the hypothetical liquid interior would be much less easily deformed by tidal forces than has been generally supposed; so that reaction upon the enclosing crust probably would not be very conspicuous. The amount of this reaction would depend essentially upon the difference between the rigidity of nickel steel and of wrought iron, which is about one fourth of the rigidity of the whole earth as now constituted. Even if one supposed the interior of the earth to be liquid, the pressure to which it is subjected is so great that the tidal surgings of the nucleus, tending to deform the crust, would be comparatively ineffective; and if the crust of solid rock like granite be moderately thick, it is doubtful if the yielding would be sufficient to reduce sensibly the theoretical height of the fortnightly tides of the ocean. Accordingly it appears probable that the argument drawn from the tides against the fluidity of the earth's nucleus may in reality be somewhat less conclusive than the most eminent mathematicians have supposed. But from the accordance between the value of the earth's rigidity obtained from the theory of gravity with those found by Darwin from observations of the fortnightly tides, and by Hough from the prolongation of the Eulerian period for the variation of latitude, it seems impossible to escape the conclusion that the rigidity of our globe as now encrusted probably approaches that of nickel steel.
>
> It is scarcely necessary to add that the traditional theory long held by geologists that the earth's interior is a mass of mobile liquid in which currents still persist (cf. Fisher's 'Physics of the Earth's Crust,' second edition, pp. 246, 305, *et seq.*) when viewed from the gravitational standpoint is, therefore, found to be inadmissible. The great effective rigidity or viscosity of the matter within the earth makes any supposed motion of the imprisoned fluid quite inconceivable.

Thus, on the one hand, I have shown by strict mathematical reasoning from recognized data admitting of little dispute or uncertainty, that the rigidity is not inconsistent with internal fluidity, while on the other, I have made it clear that the free circulation of currents within the fluid nucleus would be impossible, owing to the rigidity depending on pressure. In fact the matter within the globe, as Arrhenius has also pointed out, may well be gaseous, simply condensed by pressure till it has an average rigidity exceeding that of steel. There are forces, however, which may produce motion just under the crust, which give rise to earthquakes.

Dr. Thomson's view that 'the flexures taking place in the earth's crust or in the outer portion of its mass may bring to bear upon deep-seated and, perhaps, already heated solid rock masses a sufficient pressure to cause them to readjust their positions,' and thus give rise to volcanic action, is in accordance

with many modern speculations on the cause of earthquakes, which ascribe these tremors to the slipping of rocks. My unpublished inquiry indicates that the true cause is very different. I regret that I am not yet able to give the chain of reasoning by which this result is established, but I may say that it is shown that one common cause underlies earthquakes, volcanoes, formation of mountains and islands, the elevation of plateaus, the feeble attractions of mountains noticed in geodetic operations, and the formation of great sea waves which frequently accompany violent earthquakes. All these phenomena are proved to be intimately connected, and I have shown that they depend upon a single cause, and that the earth's crust is underlaid by a fluid substratum in which the forces arise that disturb the crust.

It is nearly always assumed that changes in the earth's crust are due to secular cooling, but is that really so? When the truth comes to be known, I think it will be found that we have all been working on a false premise; a misleading hypothesis. In *Astronomische Nachrichten*, 4104, I have shown that rigidity prevents circulation, and, therefore, secular cooling would be confined almost entirely to the surface layers. Fisher and others have shown that the shrinkage due to the cooling of the crust is quite inadequate to account for the mountain folds observed upon the earth, which my researches show to depend on an entirely different cause.

Dr. Thomson is quite right in pronouncing against radium as a cause of volcanic action. The Hon. R. J. Strutt, of Cambridge, has shown that radium is very abundant in the rocks of the earth's crust, such as granite. If, therefore, we imagine radium to be the source of volcanic outbreaks, we should expect abundant eruptions to occur in all countries underlaid with granite—the United States, Europe, Asia, Africa, Australia, Brazil—which is contrary to observation. The well-known distribution of volcanoes invalidates the radium theory completely.

The Hon. R. J. Strutt, from his radium investigations, concludes that the internal temperature of the moon exceeds that of the earth. The observed low temperature of the lunar surface, however, contradicts this hypothesis, and thus we must be very cautious about ascribing too much to radium. The best experimental evidence available is that radium is a temporary form of matter, the energy of which must be renewed from other sources at intervals of 20,000 years, and thus it may play only an inappreciable part in the physics of the universe. So far, there is no evidence that it is an important cosmical agency.

The great forces which have most profoundly modified the world will be found to be familiar ones, which are overlooked mainly because they are so simple and so near at hand.

T. J. J. SEE.

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August 16, 1906.

THE NATURE OF EVOLUTION.

ON returning from Central America I find Dr. E. A. Ortmann's paper in SCIENCE of April 27 under the heading 'Dr. O. F. Cook's Conception of Evolution.' Lest the use of this label deceive any possible patrons of the genuine preparation, it may be desirable to point out that the most important ingredients have been omitted, so that the peculiar virtues of my evolutionary eye-water are entirely lost!

To suppose that progress in evolutionary knowledge can be made by the arbitrary limitation and redefinition of terms would imply, of course, a very shallow and merely metaphysical apprehension of the concrete data of the subject. Nevertheless, conceptions of evolution have to be communicated through the medium of language, and language has to be explicit if it is to convey definitely outlined ideas. When there is a practical reason for doing so, a term may be used in a special sense, subject only to the obvious desirability that linguistic changes, whether of new words or of modified meanings, be kept down to the lowest possible limits which will serve the purposes of clear exposition for the subject in hand.

The word evolution is often used as the name of the whole study of development—a branch of biology which includes the consideration of all the attendant factors or groups of phenomena. This generalized use is often convenient and wholly unobjectionable, but as soon as the question of the causes of evolution is raised the word obtains a much more explicit sense, serving then to designate the concrete physiological process in which the characters of species are changed. To insist that the progressive transformation of species be called variation, and not evolution, introduces a merely gratuitous confusion of words, since it removes both these terms, variation and evolution, from their primary significations.

The essential idea of variation is in its application to differences caused by the environment, that is, to transverse contemporaneous displacements among the individual members of a species, and not to the progressive, chronologically extended, longitudinal changes which represent the evolution of the species as a whole. These are two distinct modes of organic motion. To call them both variation does not prove that they are the same; it only facilitates such an assumption and tempts the unwary to take it for granted that anything which can modify or displace individual organisms in the transverse direction of variation, can also cause species to move in the longitudinal direction of evolution.

The kinetic conception avoids the verbal pit-fall and finds fundamental differences between the transverse contemporaneous variation of individuals and the longitudinal succession or gradual modification of form or structure in the species as a whole. Other forms of expression become necessary in order that the two kinds of phenomena formerly covered by the variation blanket can be compared and contrasted.

At such points the interests of general literature and of professional science often diverge widely. Specialists who are unwilling to use the word evolution in a definite physiological sense would have preferred some more technical means of designating this process of change in species. It might have been called, for example, symbasic prostholysis, in allusion to the fact that it is accomplished through the association of organisms into interbreeding groups rather than as a result of the environmental influences which induce variations. The species, and not the individual, is the unit of evolution; there are as many evolutions as there are segregated groups of organisms.

'The whole process of development of the organic world, from its beginning to its end,' which Dr. Ortmann prefers to call evolution, is a merely historical conception and not a biological process at all, except as it is made up of the separate evolutions of the millions of species of which the 'organic world' is composed. What is to be gained of clearness of thought or of expression by calling the general aggregate evolution, while denying this name to the specific units of development, is not easy to perceive. Dr. Ortmann would scarcely have thought to beguile us with the hollow formula that species change by variation and that variation therefore causes evolution. But why otherwise should it have appeared so astonishing to find the word evolution used in a particular as well as in a general sense? It is necessary here to fully reciprocate with Dr. Ortmann and 'positively decline to accept' his conception of evolution, if, as now appears, it is something which takes place in the organic world at large, but does not appear in the component species.

The jury must decide who has meditated the greater violence to the English language. It is certainly Dr. Ortmann who proposes the greater restriction of the word evolution, for he would permit its use only in the general and indefinite sense, as applying to the organic cosmogony as a whole, while I would recognize in addition a definite physiological meaning, when questions of evolutionary causes are being discussed.

The conception of spontaneous change in the characters of species may not be correct, but it is at least a conception, and it permits evolution to be thought of as a phenomenon separate and distinct from accidents of en-

vironment which may intensify the normal inequalities of individuals (variation), as well as from accidents of geographical distribution by which groups of individuals may be subdivided (speciation). All these are evolutionary matters in the general sense already alluded to, but underneath all the multiplicity of more or less pertinent data and speculations is this process of change in species. It may be denied, as in the mutation hypothesis of Professor de Vries, that there is such an evolutionary motion of specific groups, but all will be ready to admit that if such progressive changes of species take place they represent the real center and essence of the subject of evolution, the physiological process of which it is of so much importance to know the conditions and causes.

The fact that evolutionary literature has become so vast a congeries of speculations should not make us forget what it is all about. Certainly it affords no sufficient reason for avoiding the use of the word evolution in describing a conception in which a continuous modification of the specific type is treated as a normal condition and requisite of organic existence.

After writing the above I have come upon a further article by Dr. Ortmann in SCIENCE of June 22, in which he appears reconciled to the new term speciation, in spite of the hoary antiquity and other objectionable features of the idea which led to the suggestion. This is very gratifying. But at the same time it becomes even more obvious than before that the title of Dr. Ortmann's previous article was misleading, for in this last review of developmental theories he leaves out of account altogether the very conception he has so recently claimed to discuss, a conception which, whether old or new, true or false, is radically diverse from any of the alternatives treated. The distinction of speciation from evolution has been taken, evidently, as the whole 'conception,' whereas it is only an incidental feature. The mistake is due, no doubt, to my continued failure to give the kinetic point of view an adequate presentation, but it may be that the discussion has now reached a stage where the distinctions can be outlined more clearly than before.

Without denying the general literary sense in which anything which has even a remote bearing or influence on evolution may be considered a factor, we may return once more to the kernel of the whole matter, the question of the true, actuating causes of evolution. The differences between the alternative interpretations may then be definitely located.

It is evident that Dr. Ortmann is discussing a generalized abstraction compounded out of the four factors or groups of phenomena, variation, inheritance, adjustment and speciation. The kinetic conception, on the other hand, treats evolution as a concrete process, carried forward through two factors which are very different from the other four, since they are resident in species and do not depend upon environmental influences. Dr. Ortmann's unwillingness to recognize evolution as a concrete process can now be understood, for the factors upon which he relies are incapable of explaining such a process, as a brief examination will show.

Inheritance, to take the oldest idea first, is a general condition of organic existence, but it has no evolutionary implication. If there were no inheritance there would be, of course, no evolution in the biological sense, but this is no indication that inheritance causes evolutionary progress. Many writers have consistently denied that inheritance causes, or tends to cause, evolution. They hold, on the contrary, that like would produce like indefinitely unless acted upon by disturbing agencies of the environment. Adaptation or adjustment to environment, whether by natural selection or otherwise, is not a cause of evolution, but rather a result, a meeting by evolutionary processes of requirements imposed by external conditions. Speciation, or the diversification of segregated groups of organisms, is also clearly an evolutionary result instead of a cause. Even variation, in the sense in which the word appears to be used by Dr. Ortmann, to indicate the effects of external influences upon organisms, has not been shown to have any connection with evolution, notwithstand-

ing the persistent faith of the apostles of mechanical causation, such as Cope, Hyatt, Dall and Dr. Ortmann himself. In short, it does not appear that the true, efficient causes of evolutionary motion are to be found in the phenomena covered by these four terms, in the senses in which they are employed by Dr. Ortmann.

The conception of which Dr. Ortmann announced a discussion, but has not really considered, definitely abandons these supposed causes of evolution as inadequate and irrelevant and would elevate to primary importance two considerations generally ignored entirely, or given very subsidiary attention. These are (1) *heterism*, the normal diversity of the individuals of which species are composed, and (2) *symbasis*, the free interweaving of the lines of descent of these normally diverse individuals.

The progressive transformation of species is made possible by these two factors, and it has not been shown that any of the others are to be reckoned as direct or actuating causes, notwithstanding the vast amount of attention devoted in the last half century to the many static doctrines under which evolution has been ascribed to one or another form of environmental influence.

It may yet be ascertained, perhaps, that the environment does in some way exert actuating influences upon evolution, but it is not too much to say that up to this time all theories of environmental causation remain purely speculative. Heterism and symbasis, on the other hand, though long neglected as evolutionary causes, are thoroughly established facts of obvious implication. Individual diversity persists in spite of uniformity of conditions, and interbreeding is everywhere coincident with evolutionary progress. Even on purely mathematical grounds it becomes apparent that the resultant of the continuous interweaving of diverse lines of descent must be a progressive transformation of type.

Dr. Ortmann points out that de Vries has confused speciation with variation, but might be charged in turn with having confused evolution with variation, just as so many other writers have confused evolution with speciation. Why so many attempts at leaving Hamlet out of the play? Each is a testimony of the surviving strength of the old pre-evolutionary idea that species are normally constant, uniform and stationary, so that evolution would need to be caused and conducted by external agencies of the environment. Though supported by no facts, the doctrine of environmental causation is still being advocated in many quarters in a manner strongly reminiscent of the defense of special creation, by Owen and Agassiz. The kinetic conception of evolution is in respect of causality as different from environmental evolution as that is from special creation, for it holds that species are not made by the environment, but that their development goes forward as a manifestation of qualities inherent in their very constitution.

The progressive modification of specific groups of interbreeding organisms is as truly a phenomenon, as much of a fact, as any of our so-called factors, natural selection, adaptation, variation, heterism, isolation, speciation, etc., which help to make up the evolutionary drama. Evolution, in the kinetic version, is not only the title of the play, but the name of the principal rôle. It is no longer restricted to the dialogue of the subordinate players, like a mere ghostly abstraction. The actions and relations of the various attendant circumstances continue to give us very important aid in understanding the workings of evolution, but they are no longer allowed to explain it away into a nebulous compound of definitions. Some of the persons are of the immediate family of evolution, but others have no direct relationship at all, though they may appear often on the stage and perform important parts. Thus natural selection is the father of adaptation, but is related to evolution only in the indirect, restraining capacity of guide and counselor. Evolution and isolation are parents of speciation, but are related only by this marriage, and had no previous consanguinity. Environmental variation is at most only an uncle of evolution, not the direct progenitor. The remaining minor

factors constitute the retainers, servants and domestic animals of the evolutionary household, but this does not give them places in the genealogy of evolutionary causes.

Dr. Ortmann is annoyed by incidental changes in familiar lines and stage directions, which he does not hesitate to charge to carelessness and ignorance, forgetting, for the time, that the whole play is being recast, and that the merits of the new rendering are to be judged by its conformity with the facts of nature, rather than by reference to the traditions of evolutionary literature.

O. F. COOK.

WASHINGTON,
July 18, 1906.

TEMPERATURE CORRECTIONS OF SUGAR POLARIZATION.

TO THE EDITOR OF SCIENCE: There has come to me a belated copy of SCIENCE (April 20) containing Dr. Wiechmann's review of my work on the polariscope, in which he discusses my treatment of the subject of temperature corrections of sugar polarizations. As Dr. Wiechmann seems to have quite misunderstood what I have stated concerning temperature corrections, in view of the great importance of the subject I have ventured to bring it again before your readers. Dr. Wiechmann takes a quotation from my book (p. 44) as to the fact that the values of temperature influence are well established [by Andrews, Wiley and Schönrock for instance] as a statement endorsing the use of temperature corrections in raw sugar polarizations. He quite overlooks the statement (on the same page, I think; I have no copy at hand) that such corrections can be *quite fallacious* if proper conditions are not observed; and yet further (p. 97†), under 'Errors of Commercial Polarizations,' where I say, that owing to other inherent errors of raw sugar polarizations it is doubtful whether application of such corrections brings any nearer approach to the true saccharimetric value; and hence, such corrections are questionable in raw products at least.

The present status of the case, as I understand it, is this:

It is well established that temperature change exerts an influence on sugar polarizations made according to standard method.

The quantitative value of such influence, when pure sugar is polarized, is known within narrow limits of error.

Owing to obscure compensatory errors, not yet possible of measurement and inherent in raw sugar polarizations, the correction of temperature influence is inadvisable as generally leading to an exaggerated sugar value. Further, application of temperature correction values gives quite fallacious results if the same constant temperature of solutions and apparatus is not maintained.

As the total errors or raw-sugar polarizations apparently come nearest to balance at 20° C. this temperature has been adopted as a rigid standard by the International Sugar Commission.

The fact that the International Commission has adopted a rigid temperature standard shows that the influence of temperature is recognized. It follows that polarizations made at temperatures other than 20°, as necessarily here in the tropics where the afternoon temperature is now from 28 to 30°, that some correction should be made for temperature influence, not to the standard, of 17.5°, but to 20°. The well-known case cited by Dr. Wiechmann simply emphasizes that 'temperature corrections' may be applied with quite fallacious results, without in any way casting doubt on the 'alleged' influence of temperature on the specific rotation of sucrose which obviously is but a small part of the influence of temperature on sugar polarizations.

Here might be raised the interesting and subtle question whether the sugar values of the saccharimeter standardized at 20° are identical with those of the instrument standardized at 17.5° when *raw* sugars are polarized.

In the whole discussion, what are facts of experiments in temperature influence on pure sugar polarizations must be carefully differentiated from what is the most consistent and fairest way to estimate the sugar value of a commercial product, by the indications of a method which at its best is subject to errors as

yet incapable of exact control; errors which are small but yet significant in the light of the magnitude of sugar transactions.

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SPECIAL ARTICLES.

A BURIED TREASURE OF ECONOMIC ORNITHOLOGY.

In 1865 there was published in New York a work on entomology by Dr. Isaac P. Trimble. Though dealing primarily with insects, the book contains the most original and accurate observations then made in economic ornithology in America. Concealed under its caption, 'A Treatise on the Insect Enemies of Fruit and Fruit Trees,'[1] is a mine of information concerning the relations of birds to some of the worst pests horticulture has to endure.

The attention to minutiæ and the scientific accuracy with which the data were gathered are remarkable for the time, and the line of investigation, undeveloped as it was. While Samuels, Michener, Flagg, Bryant, Jenks and others were working in the field of economic ornithology at that or a little earlier period, the work of few, if any of them, is marked by the wealth of definite information that characterizes the labors of Trimble.[2] His specific identifications of substances found in the stomachs and his technique of determination savor strongly of present methods, and at once distinguish his work from most of the contemporaneous articles on the subject, being, as often they were, mere compilations of Audubonian and Wilsonian phrases.

Dr. Trimble went to the birds themselves for his information. He says:

> I have killed a very large number of birds and examined the contents of their stomachs, especially of those frequenting orchards. Most of these examinations have been made with a magnifying glass, and many with the microscope. Some species I have shot at short intervals during the season, to know how far their food varied at different times; and I have thus ascertained that the contents of the stomach at any one time are not an infallible criterion by which we can determine the usual food of that bird. On the fifth of May, 1864, I shot seven different birds; they had all been feeding freely on small beetles, and some of them on nothing else. There was a great flight of these small beetles that day; the atmosphere was teeming with them. A few days after the air was filled with ephemera flies, and the same species of birds were then feeding upon these (p. 113).

Here he recognizes the law that birds as a rule feed upon substances most abundant about them, a fact with which we are constantly brought face to face in the more extensive investigations of the present time. Continuing the comparison, as we identify some beetles by the scutellum or chrysalides by the cremaster, he also had his little niceties of method, of one of which the following is an interesting description:

> The eyes of most insects are wonderfully formed. They may be said to be compound eyes, each made up of many hexagonal lenses. If a comb of the hive bee, containing one or two hundred cells, could be photographed down to the size of the head of a pin, it would look somewhat like the eye of a beetle. Each eye of the Curculio contains about 150 of these lenses. The number in the eyes of butterflies, moths or dragonflies amounts to many thousands. In some microscopic experiments made last summer upon the eyes of plant lice from different trees and plants, it was found that the number of lenses in the eyes of these insects varied from every tree and plant. Each thus proved to be a distinct species, no matter how close the resemblance in other respects. Thus, should the rose bushes of the garden or a neighborhood be cleared of these pests they would not be reinhabited by those from other plants. While examining one of these aphides it brought forth a young one, and this in turn being tested its eye was found to contain the same number of lenses as the mother's. This peculiarity of the eyes of insects, and the knowledge of the exact number of these lenses in the eyes of each species, become

[1] William Wood and Co., New York, 1865, pp. 139, pls. XI. This title is not to be found in Coues's bibliography nor in any list of publications concerning economic ornithology. By entomologists, however, the publication is frequently cited sometimes even for its ornithological matter, and its author is deemed entitled 'to a prominent place with the early economic entomologists of the country.'

[2] The latter says, however, of the work of Flagg, 'Of the many contributions to the history of birds, I have met with none so interesting as this' (p. 113).

important in investigations where only the comminuted parts can be obtained. In a long series of examinations of the contents of the stomachs of birds, for the purpose of ascertaining more positively how far the insectivorous kinds frequenting orchards are useful in feeding upon these enemies of fruits, the microscope has enabled me to demonstrate many facts otherwise difficult to prove (pp. 37–8).

How he made use of the little point about the curculio he describes in a fascinating manner:

Killed an oriole (Baltimore)—a male of one year; it did not have the brilliant colors of the fully matured bird. I followed it from tree to tree for a long time, listening to its peculiar notes, and watching its habit of feeding. In a very careful examination of the contents of the stomach, what appeared to be the wing-cases of a *Curculio* were discovered; and on further scrutiny I found the head with proboscis attached. This was exciting. Here was some evidence that one bird at least was feeding upon our most formidable insect enemy; but as the *Curculio*[3] is one of a large family of the Coleoptera, and many of the different species bear a striking resemblance to each other, both in form and size, it was necessary to pursue the investigation still further. On placing the wing cases under the microscope, the peculiar protuberances—the brilliant metallic colors—the hairs resembling pearls, when a strong light is directed upon them, that I had so often seen, were all visible. The mutilated head was now tested. There was the proboscis with its cutting apparatus, and the 147 lenses in the eye.

I have examined the eyes of many others of this family, but not one of them has the same number of lenses. The larger species figured in Pl. 5, Fig. 10, has more than double this number.

All this evidence taken together was ample to settle this question forever. The Baltimore eats the *Curculio*![4] Let the death of this martyred bird secure the protection of its race for all future time. The remains of three other beetles and three leaf-curling caterpillars[5] were also found in the stomach of this oriole (p. 77).

The Baltimore Oriole Eats the Curculio. Probably many other birds that frequent the orchard in pursuit of food, and feed upon beetles do the same thing; but none of them search it out exclusively. Therefore, good as most of the birds are as consumers of injurious insects, and though the world, for our purposes, would soon become topsy-turvy without them, the birds can not be relied upon to subdue or control the curculio (p. 85).

Here again our author gives an instance that agrees with the results of a much greater amount of study of the food of birds. That is, birds simply act as a check upon insects, sometimes as a minor one, sometimes the chief. Such must always be the case, for obviously no species can continue to exist if it exterminates its food supply.

Dr. Trimble found feathered enemies of another great insect pest, the apple-worm, or codling moth (*Carpocapsa pomonella*). This is the very task at which an entire state (California) set its energies. Indeed the little codling moth demands a good share of the attention of economic entomologists over the whole world. Our author's efforts in searching out birds that feed upon this insect are particularly interesting. He treats the work of the downy woodpecker in this direction in detail and gives a plate (X.) in figuring this bird, the yellow-bellied woodpecker and the chickadee, so that any one, whether he be acquainted with birds or not, can recognize the friends and the supposed enemy. On the same plate is shown some of the downy's work —the exterior of a piece of bark with the little round holes made by the bird's beak, and the inner side of the same showing how straight and true these tunnels were drilled through to the chrysalis of the moth. He found them at this work from September 8 (p. 135) to April 21 (p. 115), and in his accounts of every place he made observations, Dr. Trimble mentions these holes in the bark of the apple trees. Concerning a trip in Morris County, N. J., he says:

[3] His name for the curculio is *Curculio argula* Fabr., which in modern terminology is *Conotrachelus nenuphar*. The larger species he mentions is really on Pl. VI., Fig. 10, and, he explains, was figured from a specimen taken from the stomach of a toad. From stomachs of these animals he says he has often obtained different species of beetles.

[4] Now known to be eaten by many other species of birds.

[5] Tortricina. Also found by Dr. Trimble in the stomachs of the wren and catbird.

Here I was gratified in being able to ascertain how he finds where to peck through the scales of bark, so as to be sure to hit the apple worm that is so snugly concealed beneath. The sense of smell will not account for it. Such an acuteness of one of the senses would be beyond the imagination. Instinct, that incomprehensible something, might be called in to explain to those who are satisfied to have wonders accounted for by means that are in fact only confessions of ignorance. Birds have instincts undoubtedly—so have we; but they are mixed up confusedly with other faculties. Most of the actions of insects are purely instinctive and utterly unaccountable. But the apple moth is not a native of this country—the downy woodpecker is. The bird would not have been created with a special instinct to find the larva of a moth that did not exist in the same country. Other insects live under these scales of rough bark; but in very numerous examinations, I have not seen such a hole made except when leading directly into the cocoon of this particular caterpillar. This little bird finds the concealed larvæ under the bark, not from any noise the insect makes; it is not a grub of a beetle having a boring habit, and liable to make a sound that might betray its retreat, in seasons of the year when not torpid. A caterpillar makes scarcely an appreciable noise, even when spinning its cocoon, and when that is finished it rests as quietly within as an Egyptian mummy in its sarcophagus.

There is no evidence that the downy woodpecker ever makes a mistake; it has some way of judging. The squirrel does not waste time in cracking an empty nut. There is no reason to believe that this bird ever makes holes through these scales merely for pastime, or for any other purpose except for food. He knows before he begins that if he works through, just in that spot, he will find a dainty morsel at the bottom of it, as delicious to him as the meat of the nut is to the squirrel. But how does he know? By *sounding* —tap, tap, tap, just as the physician learns the condition of the lungs of his patient by what he calls percussion.[6] The bird uses his beak, generally three times in quick succession—sometimes oftener; then tries another. Watch him. See how ever and anon he will stop in his quick motions up and down, and give a few taps upon the suspected scale, and then test another and another, until the right sound is communicated to that wonderful ear (pp. 116–7).

[6] This description of the woodpecker's search for food bears a remarkable resemblance to a forty-years later (1905) account of a percussion process (Perkussionsverfahren) by a German investigator, Dr. Wilhelm Leisewitz.

Besides studying the downy woodpecker in the field he examined the stomachs of three of them. One contained *a codling moth larva* and some beetles. Another held one beetle, the heads of *two codling moth larvæ* and of three small borers. The third contained beetles and grubs unidentified.

The black-capped chickadee was also found to feed upon the codling moth. Three specimens were examined, one having eaten eggs of lepidoptera and beetles, another four seeds and a number of 'pupæ of very small beetles, such as take shelter under moss and old bark on trees,' while in the stomach of the third were *five larvæ of the codling moth.*

One of these had been so recently taken, and was so little mutilated, that it was easily identified. The heads of the other four appeared identical when examined with a pocket-glass; but when subjected to the test of the microscope, there was no possible room for doubt. The day had been dry and windy, following a warm wet day and night; and it is in just such weather that the bark of the buttonwood, shellbark hickory, and other shaggy trees, will be found curling out and falling off.

I have never seen anything that would lead me to believe that this minute bird makes the holes in the scales of bark that lead directly to the cocoons of these caterpillars; they are made by the downy woodpecker, and probably by it alone. The chick-a-dee most likely finds these worms only or chiefly on such days as this, when the warping of these scales exposes them to the prying eyes of these busy little friends. This bird is one of the guardians of the orchard; quick, active, always on the alert; assuming any position; sometimes hanging by one foot on the under side of the large limbs, where these caterpillars rather prefer to conceal themselves; and now proved to feed freely upon the second in importance of the insect enemies of our fruits. Let no one hereafter kill a chick-a-dee without being made to feel that he has done a most disgraceful deed (p. 120).

In further proof of their good work he says:

For several mornings in succession I noticed that the piazza was strewn with the cocoons and broken pupa cases of the caterpillars (species?) that were so numerous in September; sweep them off, and soon they would be there again. It was the work

of the chick-a-dees. The piazza is a high one, and extends on three sides of the house. Hundreds of caterpillars formed their cocoons in the chinks and crevices of the ceiling, and there the little birds found them (p. 121).

Among notes on other birds which he had studied, but which were not found to destroy either of the insect pests he treats, is quite a long dissertation upon the yellow-bellied woodpecker. After watching one drilling holes in an apple tree for some time, he wrote the following:

I shot this poor bird, expecting to find positive evidence in the stomach of what it made these holes for—and found two seeds or pits[1] (of which one and half the other are represented in Fig. 9, Plate 10), with the purple skins of the same fruit, seven small ants, and one insect of the chinch bug kind about the size of those found in the beds of some taverns. But of bark or sap there was not even a trace.

Later in the day I shot another of the same species of bird in an old orchard out of town. The stomach of this one contained the pulp of an apple and one ant—nothing else. This one was on the upper part of an apple tree, and was not pecking or sounding. The investigation of this bird so far is unsatisfactory. I have seen no evidence yet that these holes are made in search of food. Ants are certainly found sometimes about these holes, and apparently in pursuit of the sap that exudes from them; but the idea suggested by some, that the birds make them to attract these ants by such tempting baits, is a palpable exaggeration of the reasoning power of this bird (p. 118).

Notwithstanding the subsequent great increase of knowledge in regard to birds, the puzzling problem of the sapsucker is in almost as unsatisfactory a state at the present as when Dr. Trimble was making his pioneer investigation.

In the case of some other birds, also, of whose status we are none too sure, the author's treatise presents data. Among such birds are warblers and creepers, mentioned in the following paragraph:

The season of 1864 will be memorable as the year of aphides, or plant lice. The first crop of leaves on many of the apple trees was so alive with a species of these pests that most of them fell off, causing also a profuse shedding of the young apples. Warblers of many kinds, then just coming on from the south, creepers, wrens and even sparrows, as well as many other kinds of birds, fed upon these the livelong day. The throats, and even the back parts of the beaks of some of them, would be found lined with these aphides, many of them still alive, and their stomachs containing a juice that would leave the hands colored as they are after crushing these insects. The creases or folds of the stomachs were lined with what appeared to be an accumulation of the hairs of caterpillars, but under the microscope were found to be the legs of these plant lice—thousands and thousands of them (p. 114).

From stomach examination he learned, also, that the bobolink eats cankerworms. "I have found his stomach filled to repletion with these troublesome caterpillars" (p. 114). The same pests he finds are eaten by another bird.

I have found as many as thirty-six young canker worms in the stomach of one (cedar-bird), and I have known companies of these birds come after a species of canker worm on a cherry tree, several times every day, for two weeks, during the last summer; and when I saw them afterwards feeding upon the cherries, I felt that they had saved the crop, and were entitled to a part of it. This and several other species of birds are very troublesome to grape as well as cherry growers, and I know men who are threatening to shoot them next year. But there are two sides to this question. The grape crop would be a precarious one if its insect enemies were not kept in check, and there is no protector so efficient as the birds. Save your cherries and grapes if you can, but better lose a large portion than kill the birds (p. 26).

In the stomachs of meadow-larks he found oats and wheat and thousand legs (*Julus*), and in one of a crow shot in February a few beetles and about fifty grasshoppers.

Some of these, he says, were of the variety so plentiful late in fall, but the greater part were of that kind that we find in the spring about half grown, and not yet having their wings matured—such as are at full size in July. Many do not know that grasshoppers live through the winter; many do not know that crows eat insects. The farmers, when they see flocks of crows ransacking their fields and meadows, instead of offering bounties for their destruction, should be thankful

[1] Judging from the illustration these are evidently the seeds of the dogwood, *Cornus florida*.

that there is something to keep the grasshoppers and other insects in check (pp. 101–2).

The statements in this paragraph seem eloquent of the spirit of the man. He found out many things that others did not know and strove after a genuine appreciation of the relations of things about him. He was one of the earliest to take the direct method of doing this in the field of American economic ornithology. That his work has remained unnoticed because of a name is a pity. His observations are not trite to-day, but, on the contrary, they possess freshness, almost novelty. That such is the case after a lapse of more than forty years is a significant tribute to an able and original man.

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GALL-INSECTS AND INSECT-GALLS.

In no phase of biological work are the results of the neglect of cooperation more apparent than in the study of 'insect-galls' and 'gall-insects.' In fact many of our best scientists fail to recognize the two closely related subjects as distinct and continue to use the terms synonymously, although the one is botanical while the other is entomological. The entomologists have given considerable attention to the study of gall-insects, but the study of insect-galls has been woefully neglected, while lack of cooperation has made much of our entomological knowledge of questionable value.

For some time the writer has been bringing together the literature upon these two subjects, and it may be of interest to the readers of Science to see a summarization of the work in hand at this time. The six orders of insects containing gall-makers, include 16 families, 77 genera and 583 species (not counting leaf curlers and those for which galls have not been described, but which we have every reason to suppose are true gall-makers). These galls arranged with reference to the host plants show the following: 26 orders, 51 families, 90 genera and 188 species affected. Of the 26 orders 12 show only one family in each to be affected; of 51 families 26 have only one genus affected; of the 90 genera 63 have only one species in each affected. The genus *Quercus* leads with 45 affected species and *Salix* is second with ten affected species.

These figures are absurd and every student of either entomology or botany believes that the list of host plants should be much longer.

Let us look for an explanation: (1) The botanist has given practically no attention to the subject, although every herbarium of importance contains more or less galls that have been incidentally collected. (2) The entomologists have studied the insects rather than the galls and too often their descriptions of the galls have been indefinite. Furthermore, the determinations of the host plants in many cases have been uncertain or entirely omitted. Papers have been published without giving the common names of the hosts, others with only the common names, others with only the generic names and others in which it is evident that the determinations are incorrect. A well-known botanist in examining my list recently remarked: 'Here you have a number of galls attributed to a single host plant, while I have seen galls on four different species of that genus.' Yet, I have reason to believe that I have examined practically all the North American literature on the group of gall-formers to which he referred. I have also received from well-known entomologists, galls of the same species bearing different names.

The study of the insect-galls and their makers, parasites and inquilines presents a very large number of interesting problems of which the following may be mentioned: (1) We know very little concerning the dimorphism of the American species. (2) We know nothing of the relation of the distribution of the insect, to the distribution of the host plant. (3) We have very little reliable data concerning the ability of any one species of insect to produce galls upon more than one species of host plants. (4) Very little has been done on the anatomy of the American galls. (5) Very little has been done on the physiology of the galls.

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ALIMENTARY PARASITES OF FELIS DOMESTICA.

BELOW are given the records of the kind, location and extent of the intestinal parasitism of several specimens of *Felis domestica* examined at Meadville, Pa., during the year ending June, 1906. Only three species of parasites were found: *Ascaris mystax, Tænia crassicollis* and *Dipylidium caninum.* The two species of tapeworms were identified by Professor H. B. Ward, of University of Nebraska.

TABLE 1.

	No. of Subjects.	Subjects Affected.	Not Affected.	No. of Parasites Found. Total.	Average.	Max.	Min.
A. mystax.....	13	9	4	134	15	37	2
T. crassicollis..	17	5	12	13	2.6	5	1
D. caninum.....	17	3	14	28	9.3	16	5

Table 1 gives a general record of the extent of parasitism. This shows that parasites are abundant in *Felis domestica.* It will be seen

TABLE 2.

Detailed Record of Infection of Twelve Individuals.

Subject.	Kind of Parasite.	Age of Subject.	Total.	Stomach.	Duodenum.	Jejenum.	Ileum.	Large Intestine.
1 ♂	A. mystax.	sleek,	0	0	0	0	0	?
	T. crassicollis.	full	5	0	0	0	5	?
	D. caninum.	grown.	0	0	0	0	0	?
2 ♀	A. mystax.	sleek,	11	0	9	2	0	?
	T. crassicollis.	full	0	0	0	0	0	?
	D. caninum.	grown.	0	0	0	0	0	?
3 ♀	A. mystax.	scrawny,	16	0	14	2	0	?
	T. crassicollis.	¾	0	0	0	0	0	?
	D. caninum.	grown.	0	0	0	0	0	?
4 ♀	A. mystax.	scrawny,	0	0	0	0	0	?
	T. crassicollis.	old.	3	0	0	0	3	?
	D. caninum.		0	0	0	0	0	0
5 ♂	A. mystax.	scrawny,	22	2	18	2	0	0
	T. crassicollis.	full	0	0	0	0	0	0
	D. caninum.	grown.	0	0	0	0	0	0
6 ♀	A. mystax.	¾	37	3	22	4	2	6
	T. crassicollis.	grown.	0	0	0	0	0	0
	D. caninum.		0	0	0	0	0	0
7 ♀		sleek, full grown.	No parasites found.					
8 ?	A. mystax.	½	2	0	2	0	0	0
	T. crassicollis.	grown.	0	0	0	0	0	0
	D. caninum.		0	0	0	0	0	0
9 ♂	A. mystax.	large,	20	0	17	3	0	0
	T. crassicollis.	sleek,	1	0	0	1	0	0
	D. caninum.	butcher's cat.	0	0	0	0	0	0
10 ♀	A. mystax.		12	2	9	0	0	1
	T. crassicollis.	?	0	0	0	0	0	0
	D. caninum.		0	0	0	0	0	0
11 ♀	A. mystax.	scrawny,	3	0	3	0	0	0
	T. crassicollis.	1½ year.	0	0	0	0	0	0
	D. caninum.		16	0	0	0	16	0
12 ♂	A. mystax.	old,	11	1	9	0	0	1
	T. crassicollis.	pet.	0	0	0	0	0	0
	D. caninum.		0	0	0	0	0	0
Totals.	A. mystax.		134	8	103	13	2	8
	T. crassicollis.		9	0	0	1	8	0
	D. caninum.		16	0	0	0	16	0
Grand Total.			159	8	103	14	26	8?

that 88 per cent. of all the subjects examined were infected by some one of these parasites and that 76 per cent. of all the subjects infected were infected by *Ascaris mystax*.

Table 2 gives a detailed record of the age and sex of each subject and the location and extent of the parasitism.

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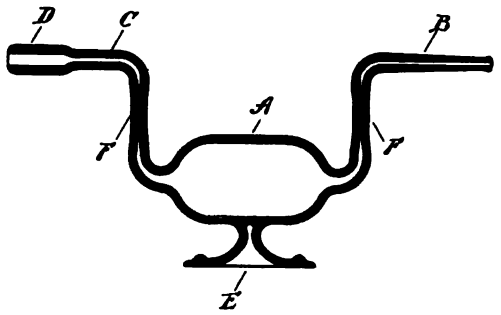
AN IMPROVED PYKNOMETER.

In the course of investigation into the function of the bones of the middle ear there was occasion to determine the specific gravity of those ossicles and their constituent parts. The parts are very small, so that the most suitable method for determining their specific gravities seemed to be that employed by Hammerschlag for determining the specific gravity of a drop of blood.

The specific gravity of methylene bromide, which is greater than that of bone, was gradually reduced by adding ether to it, until the piece of bone under investigation which had been dropped into this solution, remained suspended therein. At this point the specific



gravity of the particle of bone was, of course, the same as that of the solution, which latter was then determined.

I attempted to use the pyknometer with a perforated stopper to obtain equal quantities of the solution and of distilled water for the purpose of comparing their weights; but found the instrument unsatisfactory for exact determinations.

The water did not overflow the stopper as readily as the solution, forming a much larger cap over the perforation so that an equal quantity of water and of methylene bromide could not be obtained. Furthermore, during the necessarily slow process of careful weighing, three to four mg. of the solution would evaporate. Besides, unless special care was taken, a rising temperature would cause the contents to overflow.

To obviate these difficulties, I designed a pyknometer here illustrated in vertical section.

The cylindrical body or bulb, of convenient size *A*, is provided at one end with a capillary inlet—outlet tube or arm *B*, bent as shown; at the other end with a similar tube or arm *C*, having a mouthpiece *D* for drawing in and blowing out the liquid. The arms *B* and *C* are marked as at *F*, *F*; the whole is mounted on a suitable base such as *E*; by drawing in or blowing out, the exact quantity of liquid can readily be obtained; the lumen of the arms at the marks *F*, *F* may be extremely narrow and a perfect gauge of quantity be thereby had; no attention need be paid to changes in temperature after the pyknometer is once filled; the lumen being narrow and the arms long, what little evaporation might possibly take place is beyond detection; the instrument is conveniently cleaned and dried by rinsing it with a volatile solution and then passing an air current through it.

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CURRENT NOTES ON METEOROLOGY.

THE CYCLONE OF SEPTEMBER 22–28, 1905, IN THE PHILIPPINES.

The *Bulletin* of the Philippine Weather Bureau for September, 1905, lately received, contains an excellent account of an important tropical cyclone which swept over the Philippines from the twenty-second to the twenty-eighth of that month, over a belt more than a hundred miles wide. This cyclone has been given the name *Cantabria*, after one of the vessels which was wrecked by the storm. The place of origin seems to have been in long. 142° E., and lats. 11°–12° N., between the islands of Guam and Yap. It moved west to Samar, and then northwest to the mainland,

at an average speed of 13.5 miles an hour. Several interesting reports were received concerning the passage of the central 'eye.' Thus, Capt. T. A. Hillgrove, of the cutter *Basilan*, at anchor, noted:

Between 8 and 9 P.M. wind and sea suddenly died down, the sky cleared, and stars became visible. The calm lasted for fifteen minutes. The barometer remained 10 mm. below the graduated glass (700 mm.). After the calm, the wind rushed in from the southeast with hurricane force, and the barometer began to rise.

Before the 'eye' the wind was north. The *Basilan* did not pass through the exact center. The *Pathfinder*, ten miles south, experienced but three minutes of calm. The true center passed between the two vessels, and was, therefore, of very small radius. Later on, observations show that the calm central area increased in size. At Manila, where the center was 24 miles from the city, wind velocities of 90 to over 100 miles an hour were recorded. There is evidence that both ascending and descending winds were produced. In one case roofs fell in, as if overwhelmed by a weight on top. The ocean swell was particularly heavy, and had much to do with the loss of several vessels, including the *Cantabria*. We wish to call special attention to the very complete set of illustrations which accompany this report, including views of damage done on shore; of wrecked vessels; maps of the cyclone track and of the weather conditions; and reproductions of numerous instrumental records.

KITE FLYING IN INDIA.

THE extent to which scientific kite-flying has made its way around the world is evidenced by the publication, as Vol. XX., Part I., of the famous *Indian Meteorological Memoirs*, of 'An Account of the Preparations made for Determining the Conditions of the Upper Air in India by Means of Kites.' The writer is J. H. Field, deputy meteorologist; the date of publication, 1906. One of the chief objects of the work was the determination of the distinctive characters of the monsoon currents in India, leading to other questions in connection with the penetration of the Bengal monsoon current into the country along the base of the Himalayas. The flights took place between August 26 and September 12, 1905, a short distance (9 kms.) from Karachi City. The results show that a nearly saturated stratum of air from the sea extended from about 10 meters above sea-level upwards to a level which rose from 500 m. on August 27 to 1,130 m. on August 31. After that day, until September 9, its limiting height was not reached by the kite, but probably exceeded 1,000 m. By September 12 the upper limit fell again to 600 m. Above this nearly saturated stratum, an extremely dry wind was encountered, the recorded humidity (possible error of 10 per cent.) being in some cases only 5 per cent. to 10 per cent. These warm upper winds were of land origin, and showed very rapid diurnal changes of temperature. The report is well illustrated by means of vertical temperature gradient diagrams, as well as by weather maps.

WORK OF THE PHILIPPINE WEATHER BUREAU.

SOME idea of the amount of work now being done by the Philippine Weather Bureau may be gained from the fact that the *Annual Report* of the director for the year 1903, which has recently been mailed, embraces 1,128 pages, quarto size, of tabulated meteorological observations. With such a volume in hand, or rather on one's desk, for it is too heavy to hold, one who did not know what the Philippine Weather Service has done would be inclined to say, What a hopelessly extravagant expenditure of time and money to collect and publish these data! But the Manila Observatory, and the whole meteorological service, have made the most excellent use of their records. It would be well for meteorology if as good use had everywhere been made of the results of the daily weather observations.

CLOUDINESS AND ASTRONOMICAL OBSERVATORIES.

THE value of accurate records of cloudiness is emphasized by certain suggestions contained in a recent paper by Professor E. C. Pickering, on 'An International Southern Telescope' (*Proc. Amer. Philos. Soc.*, XLV., 1906, 44–53). If the earth be divided into cloudy and clear halves, nine tenths of the present observatories lie in the cloudy regions. It is

a striking fact that if the three extensive clear regions of the earth are considered, there are no large observatories located within them. The interior of northern Africa has no large observatory. The only large observatory in South Africa is in Cape Town, an exceptionally cloudy part of that region. In Australia, the clear interior is left unoccupied, while the two principal observatories are on the coast, at Sydney and Melbourne. The well-known Harvard Southern Observatory, at Arequipa, Peru, is handicapped by clouds in summer (November to March). There seems a possibility of excellent conditions in South Africa, but it is doubtful as yet whether the conditions would be better than at Arequipa.

R. DeC. Ward.

Harvard University.

PALEONTOLOGICAL NOTES.

THE PENGUINS.

Dr. Wiman's and Dr. Ameghino's papers on fossil penguins are so important as to demand review, although it is some little time since they appeared. Dr. Carl Wiman deals with the bones of fossil penguins obtained at Seymour Island by the Swedish South Polar Expedition; Dr. Florentino Ameghino while nominally giving an enumeration of fossil penguins of Patagonia and Seymour Island gives descriptions and figures of all the species and also discusses their probable origin. Dr. Wiman describes as new five species, each of which is referred to a new genus, while Dr. Ameghino describes nine new genera and thirteen new species, and also replaces the nomen nudum *Apterodytes* by *Paleoapterodytes*. Dr. Wiman, who is very conservative, states that his specimens may represent more than the five species described since, owing to the conditions under which they were found, it has not been possible to correlate the bones. Adding to the nineteen genera and thirty-one species admitted by Ameghino, the seven additional genera and eighteen species given in Sharpe's hand list, we have a total of twenty-six genera and forty-nine species of penguins. None of the existing genera, comprising seventeen species, have as yet been found in a fossil state.

Dr. Wiman ascribes the formation from which his specimens came to the Eocene, but in a note states that Dr. Wilckens, basing his opinion on the marine invertebrates, considers them as Oligocene or Lower Miocene. This agrees pretty well with the views of Ameghino, who holds that Seymour Island is geologically a portion of Patagonia and the horizon of Wiman's specimens Miocene. The point of greatest interest is that both authors state that the earlier species of penguin, so far as shown by their limbs, and especially by the tarsi, are much more generalized than the living species and Wiman, in particular, says that his specimens show a much closer resemblance to the corresponding bones of carinates than do the same parts of modern penguins. The tarsi, it may be said, are comparatively longer in the fossil species than in recent forms and their component bones much less clearly indicated. This is exactly the reverse of what should be found, if the generally accepted theory that the tarsus of the penguin is a survival of the primitive free condition of the tarsal bones, is correct, and further discoveries may, of course, bring to light forms ancestral to the penguins in which the tarsal bones are free. Still it is to be remembered that in *Archæopteryx* the tarsals are fused and this is also the case with the known cretaceous birds in some of which the tarsus is highly specialized. The above facts agree with my own view that a large portion of the characters which have been held to place the penguins in a group apart from other Euornithes, are purely adaptive and while the adaptive features of the short broad tarsus may not at first be evident, it is very likely correlated with the habit of sitting with the tarsus on the ground when at rest. In walking, the tarsus is held upright as in any other bird. Right here, it may be well to say a word or two in regard to the tarsus of *Ceratosaurus*, which is referred to by Dr. Wiman, and to state that Dr. Baur was entirely correct in ascribing the union of the tarsals in this genus to pathological causes. The type of this genus is in the U. S. National Museum

and the bones of the tarsus were broken and healed during life, the accompanying exostosis soldering them together. It is most unfortunate that this wilful error should be perpetuated, but like Richardson's figure of the pouched rat, it will probably endure for generations to come.

The most generalized penguins are placed by Ameghino in the family *Cladornidæ* including but two species, *Cladornis pachypus* and *Cruschedula revolva*. The figure of this last is poor and from this alone it is not quite evident why it should be placed with the penguins at all. Wiman and Ameghino agree in considering that the penguins originated in the Southern Hemisphere and that they have always had much the same distribution as at present. Ameghino further believes they descended from species that inhabited the vicinity of fresh water. The known facts bear out the first conclusion, but in view of the little we know regarding the history of birds it will be best to accept it subject to further revision.

The above notes had just been sent in when Dr. Abel's paper from Centralblatt für Mineralogie * * * was received. In this Dr. Abel discusses the bones described by me in 1900 as the pelvis of Zeuglodon and concludes that they are really the coracoids of a gigantic bird which he names *Alabamornis gigantea*.

The paper seemed so clear and convincing that this conclusion was at once accepted and a brief review begun on that basis. As this proceeded it became evident, with my knowledge of the bones in question, that if they were the coracoids of a bird, that bird was extraordinary not say exceptional in many particulars. It has, therefore, seemed best to postpone the review of Dr. Abel's paper until later in order to better examine certain details and if possible, reexamine the bones themselves. This is not for the sake of mere argument as to whether the bones are those of a bird or beast but because, if they are from a bird, they are most important.

The bearing on this particular article lies in the fact that Dr. Abel finds the nearest resemblance to these bones in the coracoid of *Anthropornis*, described by Dr. Wiman, although the differences between the two are great.

F. A. LUCAS.

SCIENTIFIC NOTES AND NEWS.

DR. A. A. MICHELSON, professor of physics at Chicago, has been elected a foreign member of the Accademia dei Lincei, Rome.

DR. L. A. BAUER has been elected a corresponding member of the Göttingen Royal Academy of Sciences.

IN connection with the recent meeting of the British Medical Association in Toronto, McGill University, Montreal, will confer the degree of LL.D. *in absentia* on Sir Thomas Barlow, Sir William Broadbent, Professor Allbutt and Sir Victor Horsley.

THE Graefe medal of the German Ophthalmological Society has been awarded to Dr. Ewald Hering, professor of physiology at Leipzig.

DR. KUNO FISCHER has retired from the professorship of philosophy at Heidelberg.

DR. SIMON SCHWENDENER, professor of botany at Berlin, has celebrated the fiftieth anniversary of his doctorate.

Nature states that Mr. William Lutley Sclater has resigned the directorship of the South African Museum, Cape Town, which he has held for the last ten years, and has returned to England. He has accepted the post of director of the museum of Colorado College.

FROM the same journal we learn that Mr. Michael John Nicoll, who recently returned from accompanying the Earl of Crawford as naturalist during his winter voyage in the *Valhalla*, R.Y.S., round Africa, has accepted the post of assistant director of the Zoological Gardens at Giza, near Cairo, and has left England to take up the duties of his appointment.

DR. FRIDTJOF NANSEN, the Norwegian minister to Great Britain, has accepted the presidency of the Social and Political Education League in succession to Professor F. W. Maitland.

Dr. E. Grossmann, assistant in the Observatory of Kiel, has been made an observer for the Commission of International Geodesy under the Munich Academy of Sciences.

Mr. John Evershed, has been appointed assistant director of the Kodaikánal Observatory.

Dr. Kaunhowen has been appointed geologist in the Geological Bureau at Berlin.

Captain Lenfant, the French explorer, is about to leave on another expedition to West Africa in order to discover, if possible, a navigable waterway connecting Lake Chad with the coast of the Atlantic.

Professor A. Gruvel, formerly of Bordeaux, has been appointed to examine and report on the sea and river fisheries of the French possessions in West Africa.

Professor W. Kükenthal, of Breslau, will this winter make a zoological expedition to the West Indies under the auspices of the Berlin Academy of Sciences.

The committee of the Pettenkofer foundation at Munich has awarded its annual prize of 1,200 Marks to the late Dr. Fritz Schaudinn, for his researches on the protozoa. The prize will be given to his widow. A movement has been set on foot to raise a memorial fund to be applied for the benefit of Dr. Schaudinn's widow and children.

A portrait of Robert Bunsen by Herr Trübner, of Karlsruhe, is to be presented to the German Museum of Munich by the Grand Duke of Baden.

The portrait of Dr. A. J. Evans, F.R.S., to be painted by Sir W. B. Richmond, R.A., is to be placed in the Ashmolean Museum, Oxford, in commemoration of his services to archeology.

The Swedish Geographical Society is about to erect at Stockholm a monument in memory of Andrée and his companions Strindberg and Fraenkel.

William Buck Dwight, professor of geology at Vassar College since 1878, died on August 29 at Cottage City. He was born at Constantinople in 1833, the son of an American missionary, and graduated from Yale University and the Union Theological Seminary. Professor Dwight was a fellow of the American Association for the Advancement of Science and one of the original fellows of the Geological Society of America. He was the author of researches on Cambrian and Ordovician geology.

Dr. Alexander Bogdanow, professor of pathology at Odessa, has died at the age of fifty-two years.

Dr. Hans Jahn, associate professor of physical chemistry in the University of Berlin, died on August 7, at the age of fifty-three years.

The death is announced of M. Léon Adrien Prunier, professor of pharmacology at Paris, at the age of sixty-five years.

The late Professor Tarnowski, the Russian dermatologist, has bequeathed his estate for the establishment of a sanatorium for physicians.

It is reported from Yokohama, Japan, under date of August 27, that the magnetic survey yacht *Galilee*, which sailed from San Francisco about a year ago under the auspices of the department of terrestrial magnetism of the Carnegie Institution, was driven on the breakwater at Yokohama during a typhoon on August 24. It was considerably damaged, but has been refloated and docked for repairs. The crew and scientific men are safe.

At a conference of the International Geodetic Association to be held at Budapest on September 20, the principal topics considered will be the accurate surveying of mountain chains subject to earthquake, with a view to ascertaining whether these chains are stable or whether they rise and sink, and the taking of measures of gravity so as to throw light upon the distribution of masses in the interior of the earth and upon the rigidity of the earth's crust. The drawing up of preliminary reports on these two questions has been entrusted to M. Lallemand, director of the general survey in France, and Sir George Darwin.

The fifth biennial meeting of the International Commission for Scientific Aeronautics

will be held this year at Milan, from September 30 to October 7. A program for continuing the meteorological exploration of the atmosphere will be adopted, and it is expected that the president of the commission, Professor Hergesell, will state the results of soundings of the atmosphere, which he has just executed near Spitzbergen from the Prince of Monaco's yacht, and that Messrs. Teisserenc de Bort and Rotch will give an account of the second Franco-American expedition which they sent last winter to the tropical Atlantic for a similar purpose. This country will be represented at the meeting by Mr. A. Lawrence Rotch, director of Blue Hill Observatory, who is the American member of the commission.

WE learn from *Nature* that the Otago University Museum has been enriched by a valuable collection of eggs of New Zealand birds presented by Dr. Fulton, and also by the gift of a large series of ethnological objects from Mr. and Mrs. James Mills. The latter, which are chiefly weapons, are mostly Polynesian, and were collected some twenty-five years ago.

THE work of the State Geological Survey on the coal fields of Illinois is going rapidly forward. A large number of mines already have been visited, and careful samples taken for laboratory study, 160 such samples being now on hand. Director Bain recently visited the Livingston and La Salle County fields, preparatory to making careful surveys. J. A. Udden is now engaged in working out the faults near Peoria, which have been such a constant source of annoyance and expense to operators in that vicinity. T. E. Savage is making a detailed study of the Springfield mines. J. J. Rutledge has taken up an investigation of the coals of the East St. Louis-Belleville area and F. W. De Wolf is about to begin work in Saline and Gallatin counties. His work, as also that of David White, who is making collections of fossil plants throughout the field, is carried on by the U. S. Geological Survey in cooperation with that of the state. Topographic surveys preparatory to next season's work are being carried on near Harrisburg, Marion, Herrin, Murphysboro, Trenton, Edwardsville, Alton and Talhula. A preliminary report upon the composition and character of Illinois coals is in press.

IN his report on the general progress at the British Museum (Natural History), Dr. E. Ray Lankester, director and acting keeper of zoology, states, according to an abstract in the London *Times*, that in 1905, for the first time since the opening of the Natural History Museum, the number of visits paid to the galleries by the public in any one year exceeded half a million, the total number recorded being 566,313, an increase of 95,756 over the total in 1904 and of nearly 80,000 over that of any previous year. The number of visits recorded as having been made on Sunday afternoons was 70,084, as against 60,909 in 1904. The average daily attendance for all open days during the year was 1,560.09; for week-days only, 1,600.73; and for Sunday afternoons, 1,322.34. The total number of visits paid during the year to the department of zoology by students and other persons requiring assistance and information amounted to 11,811, as compared with 11,824 in 1904 and 11,627 in 1903.

AN exhibition of apparatus useful in the teaching of regional geography was held in the Outlook Tower, Edinburgh, from July 6 to 14. The exhibition had special reference to the region immediately round Edinburgh.

IT is said that Staten Island has been practically freed from mosquitoes by the expenditure of an appropriation of $17,000. An area of salt marshes equal to twenty square miles has been drained. It is estimated that 230 miles of ditches, ten inches wide by two feet deep, have been dug this summer. Literature giving directions for the care of private premises directed toward the prevention of the propagation of mosquitoes has been distributed.

THE fourteenth International Congress of Hygiene and Demography will be held in Berlin from September 23 to 29, 1907. The work of the congress will be distributed among eight sections, as follows: (1) Hygienic Microbiology and Parasitology; (2) Hygiene of

Nutrition and Hygienic Physiology; (3) Hygiene of Childhood and School Life; (4) Industrial Hygiene; (5) The Prevention of Infectious Diseases and the Cure of Patients suffering therefrom; (6) *a*, Hygiene of the Dwelling and the Community; *b*, Hygiene of Traffic; (7) Military, Colonial and Marine Hygiene; (8) Demography. An exhibition is to be held in connection with the congress.

The Academy of Sciences of Berlin has received the preliminary report of the mission which went to Abyssinia last spring to explore the ruins of the ancient city of Aksum.

It is said that valuable documents relating to Volta were destroyed in the fire at the Milan International Exposition, which caused a loss of some $2,000,000.

Foreign journals announce that Dr. W. J. Goodhue, medical superintendent of the Molokai Leper Settlement, has, after several years of research, succeeded in demonstrating the bacillus of leprosy in the mosquito (*Culex pungens*) and the common bed-bug (*Cimex lectularius*).

The British home secretary has appointed a departmental committee to inquire and report what diseases and injuries, other than injuries by accident, are due to industrial occupations, are distinguishable as such, and can properly be added to the diseases enumerated in the third schedule of the Workmen's Compensation Bill, 1906, so as to entitle to compensation persons who may be affected thereby. The chairman of the committee is Mr. Herbert Samuel, M.P., parliamentary under-secretary of state for the Home Department; and the members are Professor Clifford Allbutt, F.R.S., regius professor of physics at Cambridge University; Mr. H. H. Cunynghame, C.B., assistant under-secretary of state, Home Office; and Dr. T. M. Legge, medical inspector of factories.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of the late Theodore Kearney, of Freno, his entire estate, amounting to about $1,000,000, is bequeathed to the department of agriculture of the University of California. It is said that the will will be contested by a cousin, under the provisions of the California law that not more than one third of an estate shall be bequeathed to charity when there are legal heirs. The will takes cognizance of this section of the code, and appoints four prominent men to inherit any portion of his estate which can not legally go to the university. It is also claimed that the State University is not a charitable institution, but part of the state government.

According to *The Athenæum* the number of matriculated students at the German universities during the summer term is 44,942, an increase of over 3,000 on last year. Of these 6,569 are at Berlin, 5,734 at Munich, 4,147 at Leipsic, 3,275 at Bonn, 2,350 at Freiburg, 2,128 at Halle, 1,925 at Göttingen, 1,922 at Heidelberg, and 1,362 at Jena, while the rest are distributed among various universities. There are 12,413 students of law; 10,752 are studying philosophy, philology or history, 6,584 medicine, and 6,212 mathematics or natural science. The number of students has nearly trebled during the last thirty years, the returns for 1876 showing that in that year the entries amounted only to 16,812.

Mr. Leroy Abrams, of the Smithsonian Institution, a former instructor in Stanford University, has been made assistant professor of systematic botany at Stanford.

M. Carlo Bourlet has been appointed professor of descriptive geometry in the Paris National Conservatory of Arts.

Dr. Möller has been appointed director of the Forest School at Eberswalde.

Dr. David von Haussmann, of Berlin, has been called to the chair of pathology at Marburg.

Dr. Karl Hintze, professor of mineralogy at Breslau, has been called to Bonn.

Dr. Arnold Sommerfeld, professor in the Technical Institute at Aachen, has accepted the chair of theoretical physics at Munich.

Professor Röntgen, of Munich, having declined the offer of the chair of physics at Berlin University in succession to the late Professor Paul Drude, the direction of the physical institute has been temporarily placed in the hands of Professor Nernst.

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BOTANY IN ENGLAND.[1]

THE period of twenty-five years that has elapsed since the British Association last met in this city all but includes the rise of modern botany in this country. During the middle decades of last century our botanists were preoccupied with arranging and describing the countless collections of new plants that poured in from every quarter of an expanding empire. The methods inculcated by Linnæus and the other great taxonomists of the eighteenth century had taken deep root with us and choked out all other influences. Schleiden's 'Principles of Botany,' which marked a great awakening elsewhere, failed to arouse us. The great results of Von Mohl, Hofmeister, Nägeli and so many other notable workers, which practically transformed botany, were at first without visible effect.

It was not that we were lacking in men capable of appreciating the newer work. Henfrey, Dr. Lankester (the father of our president), not to mention others, were continually bringing these results before societies, writing about them in the journals, and translating books. But the thing never caught on—it would have been surprising if it had. You may write and talk to your contemporaries to your heart's content, and leave no lasting impression. The

[1] Concluding part of the opening address of Professor F. W. Oliver, F.R.S., president of the Section of Botany, at the York meeting of the British Association for the Advancement of Science.

schools were not ready. No movement of the sort could take root without the means of enlisting the sympathies of the rising generation. It was only in the seventies that effective steps were taken to place botany on the higher platform; and the service rendered in this connection by Thistleton-Dyer and Vines is within the knowledge of us all. Like the former in London, so the latter at Cambridge aroused great enthusiasm by his admirable courses of lectures. Great service, too, was rendered by the Clarendon Press, which diffused excellent translations of the best continental text-books—a policy which it still pursues with unabated vigor, though the need of them is, I hope, less urgent now than formerly. Already at the time of the last meeting in York (1881) a select band of Englishmen were at work upon original investigations of the modern kind. The individuals who formed this little group of pioneers in their turn influenced their pupils, and so the movement spread and grew. It would be premature to enter fully into this phase of the movement, so I will pass on with the remark that modern botany was singularly fortunate in its early exponents.

Whenever the history of botany in England comes to be written, one very important event will have to be chronicled. This is the foundation of the Jodrell Laboratory at Kew, which dates from the year 1876. Hidden away in a corner of the gardens this unpretentious appendage of the Kew establishment has played a leading part in the work of the last twenty-five years. Here you were free to pursue your investigations with the whole resources of the gardens at your command. I suppose there is hardly a botanist in the country who has not, at some time or other, availed himself of these facilities, and who does not cherish the happiest memories of the time he may have spent there. Certainly Jodrell displayed rare sagacity in his benefactions, which included, in addition to the laboratory that bears his name, the endowments of the chairs of animal physiology and zoology at University College, London.

Sir William Thistleton-Dyer, who has so recently retired from the directorship of Kew, had every means of knowing that his happy inspiration of founding a laboratory at Kew was a most fertile one. It would not be surprising if the future were to show that of the many changes inaugurated during his period of service this departure should prove by far the most fruitful.

Another incident belonging to the early days ought not to be overlooked: I refer to the notable concourse of continental and American botanists at the Manchester meeting of the British Association in 1887. The genuine interest which they evinced in our budding efforts and the friendly encouragement extended to us on that occasion certainly left an abiding impression and cheered us on our way.

We are not forgetful of our obligations. We regard them in the light of a sort of funded debt on which it is at once a pleasure and a duty to pay interest. The dividends, I believe, are steadily increasing—a happy result which I am confident will be maintained.

But I should be lacking in my duty did I permit the impression to remain that botany is anything but a sturdy and natural growth among us. The awakening, no doubt, came late, and at first we were influenced from without in the subject-matter of our investigations. But many lines of work have gradually opened out, whilst fruitful new departures and important advances have not been wanting. We still lean a little heavily on the morphological side, and our most urgent need lies in the direction of physiology. As chemists and physicists realize more fully the possibilities of

the 'botanical Hinterland,' one may expect the conventional frontier to become obliterated. As Mr. F. F. Blackman has pointed out in a recent interesting contribution,[2] the chemist's point of view has undergone a change with the growth of the science of physical chemistry, and is now much more in line with that of the biologist than was formerly the case. This natural passage from the problems of the one to those of the other should be the means of attracting into our body recruits possessing the necessary chemical equipment to attack physiological problems.

As the position gains strength on the physiological side, it will become possible to render more effective service to agriculture and other branches of economic botany.

This is of importance for a variety of reasons. Among others it will bring public support and recognition which will be all for good, and it will provide an outlet for our students. It will also afford unrivaled opportunities for experiments on the large scale. Even should economic conditions, which compel us to import every vegetable product, continue to prevail in this country, this will not be so in the colonies. As time goes on, one may reasonably expect an increasing demand for trained botanists, ready to turn their hands to a great variety of economic problems.

From this rough sketch we see that the prevailing school of botany has arisen very independently of that which preceded it. The discontinuity between them you might almost call abrupt. All through the middle parts of the last century we were so busy amassing and classifying plants that the great questions of botanical policy were left to solve themselves. Great herbaria became of the order of things: they received government recognition, and they continue their work apart. Those who built up these great collections neglected to convince the schools of the importance of training a generation of botanists that would use them. The schools were free, and they have gone their own way, and that way does not lie in the direction of the systematic botany of the herbarium. So long as this tendency prevails the herbaria must languish. When I say languish, I do not mean that they will suffer from inefficient administration—their efficiency probably has never been greater than at the present time. But the effort involved in their construction and upkeep is altogether disproportionate to any service to which they are put. Work, of course, comes out of them; it is no question of the devotion or ability of individuals. It is the general position, the isolation of systematic botany, to which attention should be directed with a view to its alleviation.

If things are left to take their course there is the fear of atrophy through disuse. The operation of the ordinary economic laws will no doubt serve to fill vacancies on the staff as they arise, but the best men will be reluctant to enter. Of course the pendulum may begin to swing the other way, though no indication of such a change is yet apparent.

Let us now attempt an analysis of some of the causes which have led to this condition of affairs.

In the first place, our two national herbaria (Kew and the British Museum) stand apart from the ordinary botanical current. They are administered, the one as a portion of the Kew establishment under the board of agriculture, the other as a department of the British Museum under a board of trustees. Neither has any connection, direct or indirect, with any university organization. The keepers and

[2] 'Incipient Vitality,' *New Phytologist*, Vol. V., p. 22.

assistants as such have no educational functions allotted them; I mean positions in these herbaria carry no teaching duties with them. There are no facilities for teaching; there are no students. No machinery exists for training recruits or for interesting anybody in the ideals and methods of systematic botany. A recent event illustrates my meaning better than any words. My friend Dr. Rendle accepted the keepership of the botanical department at the British Museum a few months ago. Previously, as assistant, he had held a lectureship at a London college. One of the first consequences of his new appointment was his retirement from the teaching post. Now that was bad. Under the conditions which one would like to see there would have been no resignation. On the contrary, the keepership should have entitled Dr. Rendle to promotion to a full professorship. I do not mean a great post, with elementary classes, organization, and so on, but one in which he would be occupied with his own branch, giving a course for advanced students, let us say, once a year during the summer months. Nor is that all. Such are the vagaries of our university organization in London that we run some risk of losing Dr. Rendle from the board of studies in botany. Automatically he ceases to be a 'recognized teacher,' and unless some loophole can be found the connection will be severed.

Next we come to the question of routine duties. These are heavy in herbaria, and must include a great many that could be satisfactorily discharged by handy attendants. As in the case of those who work in laboratories, half a man's time should be at his own disposal for original investigations. It is important, for a variety of reasons, that the members of the staff should take a leading part in advancing systematic botany.

Then there is another way in which a great economy could be effected in effort, time and money. This is the transfer of the collections and staff of the botanical department from the Museum to Kew. This is a very old proposal, first seriously entertained some fifty years ago after the death of Robert Brown. There must be endless files of reports and blue books in official pigeon-holes dealing with this question. The most recent report of a departmental committee is known to all interested in the matter. From the character of the evidence tendered it is not surprising that no action has been taken. I am at a loss to find any adequate reason for the continuance of two separate herbaria. It has been urged, no doubt, that botany would suffer if unrepresented in the museum collections at South Kensington, and that the dried collections and herbarium staff are a necessary adjunct to the maintenance of a botanical museum. But there is little force in the contention. The specimens that go to make a herbarium are not proper subject-matter for museum display; nor is there anything about herbarium work which intrinsically fits the staff to engage in the arrangement of museum cases. The function of a botanical museum is to interest, stimulate and attract. It should convey an idea of the current state of the science, and particularly of the problems that are to the front, in so far as it is possible to illustrate them. It requires a curator with imagination and ideas, as well as an all-round knowledge of his subject. He must also be an artist. Logically there is no reason why a museum should be part of the same organization as systematic collections. There is, indeed, a danger of making the museum too exhaustive. I am speaking, of course, of a teaching museum, which belongs really to the province of a university, or university extension if you

like. Systematic collections kept exposed under glass are luxuries. All the world agrees that the museum side is admirably done at South Kensington, and most people attribute this success to the systematic element which is paramount behind the scenes. But, as we have seen, this is a fallacy, and the 'museum argument' for keeping the herbarium at South Kensington may be ignored.

By the fusion of the herbaria at Kew one would look for increased economy and efficiency, more time for original work as distinguished from routine duties, and a more complete specialization.

We now approach another aspect of the question. Much has been said on the value of anatomical characters in classification, and it is pretty generally conceded that they ought to be taken into consideration, though, like other characters, they are beset with their own special difficulties. As Dr. Scott—who has always urged their importance—says:[3]

> Our knowledge of the comparative anatomy of plants, from this point of view, is still very backward, and it is quite possible that the introduction of such characters into the ordinary work of the herbarium may be premature; certainly it must be conducted with the greatest judgment and caution. We have not yet got our data, but every encouragement should be given to the collection of such data, so that our classification in the future may rest on the broad foundation of a comparison of the entire structure of plants.

This passage was written ten years ago and we are still awaiting its realization.

It is perfectly true that in the case of a recent proposal to found a new natural order of flowering plants anatomical characters find due consideration; still, on the whole, we are content to rely on the traditional methods that have been transmitted from Linnæus and the old taxonomists. So much material is always passing under the hands of our systematists that they can not devote the time for the elaboration of a fresh method. In particular there are the new things which require docketing and provisional description. Circumstances, as ever, place obstacles in our way and tend to make us unprogressive.

Now it seems to be of the first importance that reform should come from within; that these problems, which are systematists' problems, should be solved by taxonomic specialists.

I am sanguine enough to believe that much might be done by a redistribution of duties, especially if this were accompanied by the fusion of the great herbaria, to which reference has already been made. But the greatest hope, I think, must lie in the possibility of some form of alliance or understanding between the authorities responsible for the administration of the herbaria on the one hand and the local university on the other. For directly you give the keepers or assistants in the former a status in the latter, you place at the disposal of the systematists a considerable supply of recruits in the form of advanced students possessing the requisite training to carry out investigations under direction. And if this be true of the herbaria, it holds equally in all the branches of knowledge represented in the National Museum. Really I fancy our museum is rather anomalous in its isolation. I am confident that any understanding or arrangement that might be reached would be attended with great reciprocal advantage. Nor am I speaking without some data before me. The movement towards a closer relation between the museum and the university has already entered the experimental stage. For on several occasions during the last few years members of the museum staff, from more than one department, have

[3] D. H. Scott, presidential address, Section K, British Association for the Advancement of Science (1896).

given courses of lectures in connection with the university schemes of advanced study. From all I hear, the experiment may be regarded as distinctly encouraging.

Before leaving this subject it may be appropriate to recall that the English edition of Solereder's great work on systematic plant-anatomy is rapidly approaching completion, and should be available very shortly. Its appearance can not fail once more to arouse discussion as to the importance of anatomical characters. I hope the result produced may reward the devotion and labor with which Mr. L. A. Boodle and Dr. Fritsch have carried out their task.

In another and even more fundamental branch of systematic work the future seems brimful of promise. We are beginning to recognize that a vast number of the species of the systematist have no correspondence with the real units of nature, but are to be regarded rather as subjective groups or plexuses composed of closely similar units which possess a wide range of overlapping variability. That such might be the case was apparent to Linnæus, but the proof depends on the application of precise methods of analysis.

In the year 1870 our great taxonomist Bentham happened to meet Nägeli at Munich, and, as we find recorded in Mr. Daydon Jackson's interesting life, "had half an hour's conversation with him on his views that in systematic botany it is better to spend years in studying thoroughly two or three species, and thus really to contribute essentially to the science, than to review generally floras and groups of species." Bentham does not appear to have been convinced, for his comment runs: 'He is otherwise, evidently, a man of great ability and zeal, and a constant and hard worker.' At the time of this interview Bentham was seventy years old, Nägeli being seventeen years his junior. The views of the latter are now bearing fruit, as we see in the important results already obtained by de Vries and others, who are following the methods of experimental cultivation with so much success.

The supposed slowness of change has been a difficulty to many. This was one of the 'lions' left by Darwin in the way, and it has driven back many a 'Timorous' and 'Mistrust.' Now, as we are gradually perceiving, it is only a chained lion after all; a thing to avoid and pass by. The detection of the origin of species and varieties by sudden mutation opens out new vistas to the systematist, and along these he will pursue his way. It will take many years of arduous work, this reinvestigation of the species question. The collections of our herbaria form the provisional sorting-out from which we must start afresh. In the long run it may be that our present collections will prove obsolete, but that will not deter us. The scrap-heap is the sign and measure of all progress.

The garden thus becomes an instrument of supreme importance in conjunction with the herbarium, and that is another reason for the transfer of South Kensington to Kew. The resources of the latter could then be directed more fully than ever to the advancement of scientific botany, and the gardens would be revealed in a new light. For the operations and results of experimental inquiries would form a new feature, very acceptable to the specialist and public alike. And, as I am on the subject, it may not be out of place to remark that we all look forward eagerly to the time when the multifarious activities of Kew will permit the development of other features of which traces are already discernible. The arrangement of the living collections is at present based largely on horticultural convenience, geographic origin and systematic affinity, happily sub-

ordinated to an artistic or decorative treatment. In time we shall go further than that and attempt in some degree to reflect current botanical ideas in the grouping of our plants. Let me illustrate my meaning by a good example. The succulent house is generally conceded to form one of the most interesting and stimulating exhibits to be seen at Kew—not merely from the weird and grotesque forms assumed by the individual plants, but chiefly because here you have assembled together plants of the most varied affinity having the common bond of similar adaptations to a like type of environment. The principles that underlie the arrangement of the best sort of museum may be applied with advantage in the case of a garden, and with tenfold effect; for is not a live dandelion better than a dead *Welwitschia*? This feature, introduced as it would be with moderation and discretion, would immensely enhance the value of the gardens both to the student and general visitor.

But to return from this digression: on the whole the time seems ripe for the new departure. Fresh lines are opening up in systematic botany that call for special provision. Now it was evident from the circumstances of the botanical renaissance twenty-five years ago that when it acquired strength some readjustment between the old and the new would have to be made. The thing was inevitable. The administrative acts of recent years all point in the same direction. The founding of the Jodrell Laboratory, the enhanced efficiency of the gardens, the great extension of the herbarium building, all help to pave the way. But more is wanted. Reference has been made to the advantages that would attend the migration from the Natural History Museum. But it is most important of all to devise a mechanism for securing a flow of recruits to carry on the work. This would follow in the wake of a *rapprochement* with the schools on the lines already sketched out. Difficulties, no doubt, will be encountered in the initial stages of a reorganization, but these are inseparable from our bureaucratic system. A very hopeful sign is the readiness which the government has shown in instituting inquiries in the past. That nothing has come of them may be attributed primarily to the attitude of botanists themselves. If they can unite on any common policy, there should be no serious delay in giving it effect.

THE CORRESPONDENCE SCHOOL—ITS RELATION TO TECHNICAL EDUCATION AND SOME OF ITS RESULTS.[1]

AT the 1899 meeting of the Society for Promotion of Engineering Education, held at Columbus, Ohio, a paper was presented by Professor Edgar Marburg, entitled 'The Correspondence School in Technical Education.'[2] This paper aroused considerable interest, and was discussed quite generally, with the result that a committee on industrial education was appointed, of which Professor J. B. Johnson was chairman. This committee reported at the New York meeting in the following year.[3]

At the time Professor Marburg prepared his paper the total number of students enrolled in the International Correspondence Schools was about 80,000, and at the time the committee made its report the number of students enrolled was about 181,000. It was impossible at that time to furnish reliable figures in regard to the work being

[1] Read at the Ithaca meeting of the American Association for the Advancement of Science, June 30, 1906, before Section D, Mechanical Science and Engineering.

[2] *Proceedings of the Society for the Promotion of Engineering Education*, Vol. VII., p. 80.

[3] *Proceedings of the Society for the Promotion of Engineering Education*, Vol. VIII., p. 28.

accomplished; consequently, both Professor Marburg's paper and the report of the committee were, in some respects, unsatisfactory and unjust to the correspondence school.

In order that you may understand several of the facts that I am about to bring to your attention, it will be well to consider the enrolment figures for the various years since the organization of the International Correspondence Schools.

From October 1, 1891, to December 31, 1893, the total number of students enrolled was	3,105
The number of new students enrolled to December 31, 1894	2,509
The number of new students enrolled to December 31, 1895	4,491
The number of new students enrolled to December 31, 1896	6,530
The number of new students enrolled to December 31, 1897	13,677
The number of new students enrolled to December 31, 1898	38,572
The number of new students enrolled to December 31, 1899	71,885

Since December 31, 1899, we have been enrolling students at the rate of more than 100,000 per year, the total number to and including June 27, 1906, being 902,906.

It will be noted that up to and including the enrolment for 1897, the increase in the number of students was comparatively even. After this date, however, the number of students enrolled increased very remarkably. There are two reasons for this sudden increase in the enrolment. Previous to January 1, 1898, the students received their text-books in the form of paper-covered pamphlets, averaging about fifty pages each, and these were sent only one at a time to each student as he progressed with his studies. The result was that if a student failed to complete his course, he had on hand not more than two instruction papers in advance of the last one he had studied. This tended to create great dissatisfaction, and, to overcome it, we reprinted the entire text of the courses, and sent to every student, at the time of his enrolment, a set of what we term bound volumes. These volumes contained every thing that the student would receive in connection with his course of instruction, and if he failed to complete the course he had his bound volumes at any rate, and could continue studying by himself, if he so desired. This feature resulted in a great increase in the number of students. Further, previous to the latter part of 1897, the students were obtained solely by newspaper and magazine advertising. They were all enrolled through the mails and no pressure was applied to induce them to become students. About the time we began printing bound volumes we began to organize a force of solicitors. These solicitors interviewed the prospective student personally, and naturally did everything they could to increase the number of students. The result is shown by the figures above quoted.

In 1899 and 1900, the number of new students enrolled was so great, relatively speaking, that it was impossible to furnish any definite figures to the committee or to Professor Marburg to substantiate our claims, and we ourselves could not predict definitely what the outcome would be. The enrolment has been comparatively steady during the past seven years, and we are now better able to present to the society facts and statistics that will enable you to judge of the work we are doing. At the same time, we can not give you full and complete information in regard to the benefits derived by our students. We have received hundreds and thousands of letters from students who have never sent in any work at all to be examined and corrected, or who have sent in work on only one subject—as for example, arithmetic—in which letters they have stated that they

have derived great benefit from their courses. On inquiry we found that these students had studied from their bound volumes, and that the text had been so carefully prepared that they did not desire to go to the trouble of writing out the answers to the examination questions; and not caring whether or not they obtained a diploma or certificate, they never sent in any work.

Before pursuing this subject further, it will be well to consider the character of the courses we offer, and the reason why we offer so many different courses. Our system of education is based on an idea that is almost directly opposite the views held by the regular schools and colleges. The regular technical school or college aims to educate a man broadly; our aim, on the contrary, is to educate him only along some particular line. The college demands that a student shall have certain educational qualifications to enter it, and that all students study for approximately the same length of time, and when they have finished their courses they are supposed to be qualified to enter any one of a number of branches in some particular profession. We, on the contrary, are aiming to make our courses fit the particular needs of the student who takes them. If a student is employed as a helper in some shop, and desires to become a stationary engineer or draftsman, or bookkeeper, or to follow any other special branch of industry, we can offer him a course that will fit him for the particular position he has in mind. Such a student does not wish or desire to be forced to study anything that is not strictly necessary for him to learn in order to fill the position he is aiming at. Consequently, without citing other instances, it may be stated that every one of our courses, with a few exceptions, perhaps, is a special course. If a person desires to take up bridge engineering, and does not wish to learn the other branches of civil engineering, we offer him our bridge engineering course. He studies only those subjects that are necessary for him to know in order for him to understand everything we teach in regard to bridge engineering. If the person wishes to study stenography, we offer him our stenographic course. If, however, he wishes to take a course that would correspond to a course in a business college, we offer him what we term our complete commercial course, which includes bookkeeping, stenography and other subjects. If a student desires to study mechanical drawing, and does not wish to take our mechanical or mechanical engineering course, we will offer him our course in mechanical drawing, and will not compel him to study any other subject. There are many persons who already have a good knowledge of mathematics and who have a good general education. They find it necessary to have some knowledge of mechanical drawing, but do not wish to study any other subject. Such a person can take our mechanical-drawing course and learn the latest and best methods in use in the leading drafting rooms of the country.

Considered from a pedagogical standpoint, our methods are a distinct departure from any that have previously been tried. What has been stated here with regard to the methods of the International Correspondence Schools, applies with equal force to a number of other correspondence schools. These remarks do not apply to all correspondence schools, however, for the reason that some of them are conducted along an entirely different line. Attempts have been made to conduct correspondence schools by means of what may be termed the regular text-books such as are used in the ordinary school or college. Their plan

is to purchase these text-books, direct the student to study a certain number of pages or chapters and then answer a set of questions. The student's answers are corrected and returned to him, and if he desires to be informed regarding anything not clearly explained in the text, he may write to the schools and obtain the information desired. He proceeds in this way until he has finished the particular text-book he is studying. Such schools, however, have always failed, or at any rate have made very little progress, for the reason that the ordinary text-book is not adapted to the use of a person studying by himself. Another method is that in use by the University of Chicago. The student takes a regular college course, but does a part of the work at home. He can not get his degree, however, without taking about half the course in residence. This plan offers very few advantages over taking a college course in the regular manner. The student must have the same preparation and must do the same amount of work as any other student taking the same course or subject. The only requirement necessary to become a student of the International Correspondence Schools is ability to read the English language and to write it sufficiently well to be understood. Sometimes even this requirement is not fulfilled, as the student will get some one else to write his answers to the examination questions for him, from dictation. This is especially true of students speaking some language other than English. A case came up only a short time ago of a German who was unable to write English, but who induced his wife to translate the text matter to him. He dictated the answers to the examination questions, which she wrote down, and his work was corrected by our instruction department in the usual way. This is not an isolated case, but is one that occurs with considerable frequency among such students.

Inasmuch as nearly every student has a definite object in view when he takes a course, he naturally objects to anything that will delay him in obtaining the knowledge he desires. As a consequence, we frequently have several text-books treating the same subject. In some cases the text-books differ quite materially both in the amount of ground covered and in the treatment; in other cases they differ very slightly. For example, take the subject of arithmetic. We have a very complete arithmetic that is used in our English branches, teachers' and commercial courses, while for our technical courses the arithmetics are all of about the same size; they may differ slightly in the methods of treatment, but principally in the fact that the examples and illustrative citations, etc., relate to matters with which the student is supposed to be concerned in connection with his course of study. For example: in the arithmetic used in the school of mines, the examples relate to matters pertaining to mining. Another arithmetic—very similar, but having different examples and illustrative citations—is used for the courses in the school of metallurgy. This may appear to be stretching the point considerably, but our chief aim is to keep the student interested in his work and to teach him something bearing directly on the course he is taking in connection with the study of every subject in that course.

As to the results we have accomplished, it is, as before stated, impossible to furnish exact figures. Many students enrol for the purpose of studying certain subjects that will enable them to pass an examination, such as for a license for mine foreman, for engineer, etc. They do not care whether they complete a course or not, pro-

vided they get the information they need in order to pass the examination. Quite a large number of students taking our courses in marine engineering never send in any work at all. They simply take their bound volumes, study from them, pass the examination, and get their license for one of the different grades of engineer. Several years ago, the writer had considerable correspondence with the assistant foreman of the boiler department of the Richmond Locomotive Works. He was very enthusiastic regarding his work, and organized a class of about thirty-five persons employed in the boiler department, most of whom enrolled with us for our sheet-metal pattern drafting course. The superintendent and other officials of the company took great interest in his work, and furnished a room where the class could meet, and furnished desks, tables and other material, and encouraged the men generally in connection with their courses of study. The results, according to the assistant foreman, were extremely satisfactory. However, he did not furnish me with the names of any of the class until about two years after the correspondence was begun. I looked up the record of these students, and found that not a single one of them had ever sent in any work to us for correction. At the same time they were getting great benefit from their courses, and were entirely satisfied with them.

A careful examination of the records of a large number of students, for a number of years, indicates that about 60 per cent. of them send in one or more pieces of work. An examination of the records of our accounting department shows that about two thirds of the students pay in full for their courses. These facts force us to the conclusion that if a student does not pay, he does not study. There is no connection between the instruction department and the accounting department. Any student who sends in work on a paper will have his work corrected, and will have any questions answered that he may send us, regardless of whether he has paid for his course or whether he is a delinquent. At the same time, it is a fact that if a student does not pay, he does not study; while, if he does pay, as a rule, he does at least a certain amount of studying. Therefore, while our present total enrolment is a little over 900,000, it is not fair to count the actual number of students as being over about 60 per cent. of this, or about 540,000. From the figures and statistics prepared last month, we estimated that 533,000 students had sent in work on the examination questions of one or more instruction papers. From June 1, 1905, to May 31, 1906, the work on the examination questions of 517,849 instruction papers was corrected; 192,739 drawings were corrected; and 6,364 phonograph records, made by students in our language courses, were received and examined. The total number of pieces of work during this period, received from students, was, therefore, 716,952.

We compiled, about a year ago, a book giving the names, addresses and records of students who had completed about one third or more of their courses. There was excluded from this list those students taking a single subject, such as arithmetic, algebra, bookkeeping, etc., and also all the students in our school of electrotherapeutics—a total altogether of 40,261 names. The average enrolment during the period when the names were being taken off was 798,960. Hence, the number of students, living and dead, who might have been included in the book was 758,700. Taking 60 per cent. of these as active students, the number to be so counted is 455,220. The

number of names included in the book is 75,774, which is about 16.6 per cent. of the number of active students. That is, 16.6 per cent. of the number of active students have completed one third or more of their courses, as shown by our records. The number of students who have entirely completed their courses, passed their final examination and been awarded a certificate or diploma is 12,143 (up to and including June 27, 1906), or about 2.6 per cent. of the total number of active students. Although this percentage may appear low, it should be borne in mind that it will greatly increase from now on. Instead of the schools being fifteen years old, they are really only about eight or nine years old, as measured by the bulk of the enrolments. A larger proportion of students are completing their courses now than at any time in the past. And in consequence of the exceedingly large enrolment at the present time, the number of graduates will increase very materially in the next few years.

Between February 7 and April 21 we issued over 600 diplomas, an average of 240 per month. The average for the same period next year will exceed this, and may average as high as 300 per month. In consequence of a falling off in the amount of work received during the hot weather, this average will not be maintained for the whole year; but it is safe to assume that between now and this time next year, at least 2,700 diplomas will be issued. This number will be increased during the following year. The percentage of increase in the number of students receiving diplomas will be far greater than in the number of new students enrolling. This conclusion is justified by the following fact: The book before referred to which contains the names and addresses of over 75,000 students is the second edition, and was compiled between May 16 and August 9, 1905. During this period, the average enrolment was 798,960. The first edition of the book was compiled between January 18 and March 17, 1904, and the average enrolment during that period was 642,378. It was previously shown that 16.6 per cent. of the number of active students was included in the second edition of the book. I have no figures to show the exact number of names excluded corresponding to the 40,261 that were thrown out in making the previous estimate, but based on the number of students enrolled during the period that the first edition was being compiled, the number to be excluded would be 32,370. The number of names, therefore, considered in connection with the compilation of the first edition, was 610,000. Hence, the number of active students at that time would be 60 per cent. of this, or 366,000. The number of names given in the first edition was 54,500, or 14.9 per cent. of the number of active students. In the short space of sixteen months the number of persons who had become eligible to have their names inserted in the book had increased 1.7 per cent. This is a remarkable showing, and we have every reason to expect that the number of students completing their courses will increase in the same or a greater proportion.

Some of the reasons why students do not complete their courses of study have been mentioned above. It may be of interest to consider other reasons why they fail to complete their courses. As a rule, if a student has only his own inclination to induce him to devote his spare time to obtaining an education, he feels the need of an education and knows the benefit it will be to him to possess it. At the same time, most persons do not possess sufficient grit and determination to persist in the line of work they have laid out for themselves, especially when they receive no

special encouragement to do so. We do all we can to encourage the student, both by means of letters and by having our agents call on them. But there are many other influences that tend to discourage a student and to induce him to drop his course. Many students are obliged to stop studying on account of being forced to work very long hours and not having the time. Other students have an idea at the time they enrol that it will be a comparatively easy matter to study the course, and they become discouraged when they find they must work hard in order to understand the subject. Such students either do not begin to study, or else they cease studying almost as soon as they enrol.

A large proportion of our students are not only ignorant of the subject studied, but are also ignorant of *how* to study, that is, they have formed no habit of this kind, and it is necessary for us to teach them how to study, as well as the subject they do study. A large number have enrolled simply for the purpose of securing the text-books, as these are not for sale and can be obtained in no other way. Some enrol because their friends are enrolled. At the same time, when they receive their text-books and look them over, they become discouraged and never make any attempt to study. Some students may start in and work very well during the winter months and early spring, but during the summer months they stop for various reasons, perhaps temporarily; but later, when the weather has become cool again they have laid aside their enthusiasm and do not resume, or, if they do, the attempt is spasmodic, and the studies are soon abandoned.

We have absolutely no way of compelling a student to study. We can not threaten him with suspension or expulsion. We have no inducement that we can offer him beyond prizes, and these do not seem to produce the desired effect; and the student himself frequently has direct encouragement to give up his studies, by reason of adverse criticism of his relatives and friends.

A considerable number of students may cease studying for a long time—several years in fact—and then begin again, and go on with their courses. Quite a number of students have objected to doing the work we require of them, saying they did not have the time, and stopped sending work on this account. We know of one student who finished all the work in our mechanical course (which we usually estimate will require about three years to complete), with the exception of one of the papers on machine design. This student did good work, and received very high marks. At the same time, he would not complete the subject of machine design, because, he said, he did not have time to make the drawings that we required in connection with these papers. His course was of great benefit to him, and when we heard from him last he was superintendent of a large power plant, and was receiving a very good salary. On account, however, of his not having conformed to our requirements, we were unable to give him a diploma, although he had actually completed the entire work of the course with the exception of this one paper. This is by no means an isolated case, but it is one that has occurred with considerable frequency. In some cases, a student will not complete a course for the reason that it does not contain, in his opinion, as much on certain subjects as he thinks he should receive, and he does not care to study the course for the educational features only.

When we began to teach we did not know what the result of the experiment would be; and, furthermore, we did not have the demand for such a wide range of

information on certain subjects as we have now. During the last three or four years we have been very busy in rewriting all of our older courses. These new courses will cover the subjects more completely than the older ones did, and there will be a larger number of subjects than were included in the former courses. Inasmuch as the new courses will meet the demands of our students better than the old ones did, we expect that there will be a great increase in the number of students finishing such courses, or, at any rate, in the number of students studying a part or all of the courses. J. J. Clark.

THE PRESENT NEEDS OF THE HARVARD MEDICAL SCHOOL.[1]

Every one who has visited the new buildings on Longwood Avenue must feel that, so far as spacious and well-lighted laboratories are concerned, the Harvard Medical School has all the laboratory space which it will require for many years to come. What it needs now, so far as these laboratory buildings are concerned, is sufficient endowment to equip, man and run them in a manner commensurate with the laboratory opportunities afforded. The school has at the present time but a small endowment fund. A much larger one is necessary, because it is becoming more and more difficult every year to induce capable men to enter the laboratory branches of medicine. This failure to take up laboratory work as a profession is due chiefly to the salaries, which, in consequence of the greatly increased cost of living and the greater returns offered by clinical branches of medicine or by business, have become entirely inadequate. No man can live in a manner becoming the position on the salaries now paid in the laboratory departments.

[1] Read before the Harvard Medical Alumni Association at its annual meeting, June 26, 1906.

The laboratory departments have, however, this advantage over the clinical departments. They have the laboratories and so can call the ablest men from any part of the world to work and teach in them. There is nothing to prevent these departments from attaining the highest rank except a lack of endowment sufficient to attract the best men and to provide funds for necessary expenses. With this provision the best results, both as regards the education of students who are to practise in the community, as regards men trained to become the medical teachers of the future, and as regards advancing medical knowledge and investigation, can be produced.

Much as adequate endowment for the laboratory departments is needed, however, lack of endowment for these departments is not the greatest need of the school at the present time. First-class laboratory departments alone will never make a great medical school. The first function of a medical school is to turn out thoroughly trained practitioners of medicine, and to do that the clinical departments must have opportunities equal to or even greater than the laboratory departments. This is not the case at present. The clinical teachers labor under great disadvantages, owing to the fact that the medical school does not have a hospital of its own and with possibly one exception has no power of appointment of clinical men in a hospital. Consequently the clinical instructors have to do their teaching in the various hospitals of Boston, which all are under different boards of management. These boards are entirely independent of the school and some of them are little inclined to cooperate with it. The resulting difficulties, which most of the clinical teachers have to contend with, are short terms of hospital service; variability in the time of year of hospital services, especially for the younger men; and the inability of the heads of departments to

select their teaching assistants in the hospitals.

In consequence of the short terms of service in the hospitals (usually four months) the clinical teachers do not have patients under their own control throughout the school year. As a result of this condition two and often three men are needed to give the same amount of instruction that is given by one man in the laboratory departments, *i. e.*, teach the eight months of the school year. As a result of the large number of men necessarily appointed by the school under these conditions the value of a teaching position is much diminished, because the salary which can be paid to each instructor is exceedingly small and because the indirect pay received in consequence of connection with the school is by no means so great as it used to be when the relative number of instructors was much less than at present.

The months during which a man is on duty in a hospital vary from year to year. Only the older clinicians are reasonably sure of certain months. A death or a resignation may cause a shift of the time of service for several men on the medical or surgical side of a hospital. On this account it is difficult for the heads of the clinical departments to plan in detail their course of instruction for the school year and for the summer. These difficulties hold in an even more marked degree for their subordinates.

Unless the heads of the clinical departments in the school are also heads of the clinical services in the hospitals they can not choose their hospital assistants, and even when they are heads of clinical services they do not have an entirely free choice; that is, it is impossible for them to select and use on their services the men best qualified to teach. They must take as their assistants those men who fall to their service by the method of assignment at present employed. Under this condition of affairs they may have as assistants men not interested in teaching or with little or no ability in that direction. Moreover, as these younger assistants on a service change from year to year, it is impossible to have a thoroughly organized, trained and permanent teaching staff.

Some of these difficulties could be eliminated by making the services continuous, as is already the case at some of the hospitals, but other difficulties are inherent in the principle on which almost all hospitals in this country are run, namely, the selection of local men only to serve on their staffs. This leads me to speak of the most vital defect which now exists in the clinical departments of the Harvard Medical School. It is the extremely limited field of choice of clinical teachers.

Since the school has practically no power of nomination or of appointment in the hospitals of Boston, it must appoint as its clinical teachers men who already hold hospital positions. The hospitals select their men from the vicinity of the city of Boston only. The result is that the hospitals of Boston dictate all the clinical appointments in the Harvard Medical School and thereby limit the choice of all its clinical teachers to Boston.

Boston is altogether too small a field from which always to obtain the best teachers. No other departments in the university or in the medical school are thus limited. All except the clinical departments are able to select from any part of the country the man who is judged best fitted for a teaching position which becomes vacant.

The number of desirable clinical teachers is still further limited in two ways, by lack of teaching ability on the part of many who receive appointment to hospital staffs,

and by promotion in hospitals on the basis of seniority only. Hospitals for the most part select the men on their staffs on the basis of their ability as practitioners of medicine, not on their ability as teachers and investigators. As a result many hospital men are not desirable as teachers or are used with detriment to the instruction. Moreover, hospitals usually select men rather early in their careers, before they have shown whether or not they possess any marked ability as teachers or investigators. The clinical men once appointed are advanced almost invariably on the basis of seniority, so that in time every man becomes the head of a clinical service. This basis of promotion may put hospital services in the control of men uninterested in teaching or inefficient in their work. There is no method of advancing rapidly the strong man with ability as a clinician, teacher and investigator, or of weeding out the inefficient man. University development, however, is based on the vital principle of selecting the most capable young men obtainable anywhere and developing them rapidly to the limit of their capacity. As a result of this present policy of promotion in hospitals the school is sometimes obliged to select an inefficient man because he is the head of a clinic and neglect a capable young man who is subordinate to him.

The result of this marked limitation of the field of selection of clinical instructors is that the clinical teachers of the school are not always of the high grade desirable and otherwise obtainable, and the broadening influence due to the introduction of men with other standards and ideals from other parts of the country is prevented.

I do not deny in the least that the clinical teachers of Harvard have always held a high rank and that many of them have made valuable contributions to medical knowledge. I only wish to point out that through circumstances over which the clinical men themselves have no control the school is unable to call to its service the exceptional clinical man from outside of Boston and put him in charge of patients. The reason of this condition of affairs is that the school has always been a parasite on the clinical men and indirectly through them on the hospitals for its clinical teaching; *i. e.*, while it has furnished its laboratory men with laboratory space and equipment, it has not provided its clinical men with wards and patients. It is only fair to add, however, that this teaching has cost the hospitals nothing and in many ways has been of advantage to them.

The medical school of the present day is no longer a place to train men solely for the business of the practise of medicine, but has become a technical school embracing many branches of science. As teachers of these different branches, trained men are needed, just as in any other technical school, *e. g.*, of engineering. In the clinical departments of most of the medical schools in this country the clinical teachers necessarily have had to make teaching a secondary part of their vocation. They have had to seek private practise in order to make a living. There have been open to clinical men no teaching positions which paid salaries large enough to enable men to live suitably and comfortably on their salaries alone; hence there has been no incentive for a man to fit himself for such a position. The only way in which a man could become a clinical teacher was by obtaining a hospital position.

At present there exists in most hospitals in this country no method for the thorough training of young men who wish to become clinical teachers. A hospital interneship is not a sufficiently long experience, but it is all that is possible at present. Under

existing conditions, after their early hospital training, young clinical men are compelled to devote their energies to earning a living and to acquiring a practise, and it usually is several years before they receive hospital appointments, as a result of which they become available as teachers.

In consequence of the lack of proper, uninterrupted, early training under capable supervision, and as a result of the temporary want of extensive opportunity for bedside study and large experience at the most important period of his life, it is almost impossible for a clinical man to reach any commanding position as a teacher in his line of work until he is past middle life. This is not true in other lines of work.

There is no denying the fact that the Harvard Medical School has done little for its clinical men except to give them titles which might prove of value in private practise. It has paid them very small salaries and given them absolutely no assistance in their clinical teaching. The school has received from many of its devoted clinical men, some of whom have made great sacrifices for its sake and have brought it great honor and reputation, much more than it has given them.

Under present conditions, with the school giving its clinical instruction in hospitals which are under the control of others, with underpaid clinical teachers who have limited terms of hospital service, and who are unable to select from the hospital staff and from the internes, as their assistants, the men they consider best fitted to teach and to advance the knowledge of clinical medicine, the school has about reached its limit of development.

From now on the Harvard Medical School must have a new ideal to strive for, namely, well-paid clinical instructors whose chief interests shall be teaching and scientific medical investigation. In other words, the clinical departments must be put on a true university basis like the laboratory departments and entirely freed from the outside influences which hitherto have controlled them. To render this ideal possible two things are absolutely necessary:

1. A sufficient endowment to enable the school to pay clinical teachers adequate salaries so that they can afford to devote all their time to teaching and to research work.

2. A hospital of its own, or one in which it has the power of appointment, in order that it can do the following things: (*a*) Furnish continuous services to its clinical teachers. (*b*) Establish salaried teaching positions in the wards for young clinical men who will have charge (under the supervision of visiting men) of the medical students, who will carry on scientific investigation of clinical cases based on the broadest training in laboratory methods, and who will study to fit themselves to be the clinical teachers of the future. (*c*) Enable the clinical departments to call the exceptional clinical man from any part of the world and put him in control of ward patients. (*d*) Place students, after they have received sufficient preliminary training, in the wards as a part of the hospital machinery so that they all may acquire practical experience under proper supervision before they undertake to practise medicine on their own responsibility.

To demand such possibilities is perfectly reasonable. Germany owes her great clinical teachers to such a system of being able to call to any vacant clinical position the best available man in the country. Consequently men fit themselves by years of study in the hospitals to fill these clinical positions. At least two medical schools in this country have adopted the same system.

If the Harvard Medical School does not adopt some such policy it will not be able to hold a leading position in this country like the other departments of the university, but will remain a local institution, and we shall continue to hear, as often in the past, the fatal excuse of expediency instead of commanding ability urged in behalf of a clinical man's appointment.

F. B. Mallory.

Harvard Medical School.

SCIENTIFIC BOOKS.

A Text-book of Sanitary and Applied Chemistry: or The Chemistry of Water, Air and Food. By E. H. S. Bailey, professor of chemistry, University of Kansas. New York, The Macmillan Company. Pp. xx + 345. $1.40.

The purpose of this text-book on applied chemistry is best stated in the author's own words:

> A knowledge of the relations of health to pure air, unpolluted water, and wholesome food will have much to do with improvement of sanitary conditions, not only of students themselves, but, through them, of the people at large. The air is usually said to be free, but pure air and sunshine cost money, as the crowded tenements show. The best lighted and ventilated rooms are worth the most. * * *
>
> It is certainly time that the people should have some practical knowledge of food and medicine. Without this knowledge they will continually be imposed upon by those who have something to sell which may be worthless as a food, or dangerous as a medicine. * * *
>
> Schools and colleges are beginning to see their opportunity to impart a kind of knowledge that is practical and sane. * * *
>
> A thorough understanding of the facts of applied chemistry will not make the skilled workman, nor will the theories of chemistry make the accomplished cook, but a broad and thorough knowledge of the underlying principles will go very far toward developing common sense in hygiene and in the selection and preparation of food.

In fulfilling his purpose, the author in Part I. (one third of the book) discusses air and fuels in their relation to heating and ventilation, lighting by the various agents now in use, water supply and purification, disposal of household waste; he devotes a chapter to cleaning, soaps and bluing, and another to disinfectants.

In view of the fact that physicians are agreed that fresh air is the first requisite to maintaining or regaining health, it is fitting that the longest chapter in this part of the book should be given to the atmosphere. A partial analysis will serve to indicate the exhaustiveness with which the subject is treated: History of Atmospheric Theories, Composition of the Air, Methods for Analysis of Air, Carbon Dioxide in Free Air and in Closed Rooms, Effect of Impure Air on the System, Nitric Acid and Other Impurities, Ozone and its Properties, Effect of Carbon Monoxide on the system, Methods of Studying the Dust of the Atmosphere, Bacteria in City Air, Arsenic in the Air, Injurious Trades, Composition of Ground Air, Effects of Ground Air on the System, Offensive Gases.

Part II. deals with food, food materials, food accessories, preservatives, beverages and dietaries.

The method of treatment is substantially as follows: history, statistics of production and consumption, classification of various forms of a given food material, chemical composition, physical properties, methods of preparation in edible form, food value.

The lists of adulterants to be looked for and the tests to discover them constitute a timely feature.

The book contains valuable tables of composition, numerous well-chosen experiments for the student, and an extremely good, though not exhaustive, bibliography.

The style of the book and the directions for experiments, while terse, are always clear.

The plan is admirably adapted to the use of students in the higher schools, academies, agricultural colleges and technical schools. The progressive college may for once waive its fear of applied science, and welcome a book so suggestive of lines of research. It is much to be desired that every college will at least have the book in its reference case.

The student of sociology, the settlement worker and every seeker after truth must, in order to know his subject, get an acquaintance with its ancillary factors. He must have his science on a positive basis. A scientific knowledge is as necessary in questions of education, reformation and the improvement of social physical conditions as it is in the treatment of a diseased individual. In this book of Professor Bailey's the student will find much that is helpful to his understanding of the causes of the conditions of daily living. Unless he has such knowledge, he is in no position to make suggestions for betterment.

The following paragraph serves to show the value of the book in this direction:

> It is estimated that at least 10 per cent. of the income is squandered not only by the well-to-do, but frequently also by those who have a very small income and so can ill afford it, in expensive food material which affords little nutrition, in unsatisfactory methods of preparation, in selecting foods out of season, by throwing away much valuable food material, and by using badly constructed cooking appliances. Much careful investigation is needed along these lines, and painstaking instruction will ultimately improve these conditions which are at present so much deplored.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

ANIMAL MECHANICS.[1]

THE author's previous contributions to animal mechanics, to some extent in company with the late Professor W. Braune, are well known to anatomists; though it is to be feared that they are held in more respect than in intelligent appreciation. The anatomist who is not a trained mathematician can very well understand that most if not all of the models and diagrams used to illustrate the simpler problems show at most the central principle, if we may so express it, and show it in a painfully diagrammatic way. It is much as if an artist were to give us a man's face drawn in straight lines. We may say, and truly, that the essential idea is given, but that much is left out; and we are not very clear as to the precise importance of the omissions. As the mathematician adopts a more thorough system we feel an increasing difficulty in following it. We can see that the method is an improvement; we can appreciate even without full understanding (if this be not a paradox) that the work is honestly done; but a clear idea does not come to us. One of the causes of the want of sympathy between mathematicians, in so far as they are mathematicians, and the rest of the world is that the former with all their learning can not do justice to the full stupidity of the non-mathematician when the question is one of mathematics. It is impossible for him to grasp how sincere the outsider is in his ignorance, or rather in his incapacity.

This book is devoted to an analysis of the movements of joints in their mutual relations. It is clear that the simplest system is one of two rigid bars playing one on the other. If we restrict the motions to one plane a child can understand it; but if we go beyond that the ordinary man is at once out of his depth. Add one more bar still keeping to one plane, and the difficulty increases. Make the number of the bars and the planes indefinite and where are we? The mathematician would tell us to go one step at a time; but somehow we lose our heads as we should did we receive the same instruction relative to walking on the tight rope.

The author writes as follows in his preface:

> As the whole animal organism has for its first object the movement of the living body through joints, I have devoted this book in the first place to physicians, especially to physiologists and anatomists as well as to zoologists. I have therefore attempted to make the mathematical deductions so elementary and to present them in so clear a manner that they will be easily intelligible even to those who are not mathematicians.

[1] 'Theoretische Grundlagen für eine Mechanik der lebenden Körper, mit speziale Anwendungen auf den Menschen sowie auf einige Bewegungsvorgänge an Maschinen in möglichst elementar Weise dargestellt.' Von Otto Fischer. Mit 67 in den Text gedruckten Figuren und 4 Tafeln. Leipzig und Berlin, Druck und Vorlag von B. G. Teubner, 1906.

Frankly it seems to us that the work is beyond these outsiders, but we are sure that those who are competent will find it a work of much value. T. D.

Kurzes Lehrbuch der organischen Chemie. Von Professor Dr. A. Bernthsen. Neunte Auflage, bearbeitet in gemeinschaft mit Dr. Ernst Mohr. Braunschweig, Fr. Vieweg und Sohn. 1906. Pp. xxii + 638.

The approval with which this book has been received is indicated by the fact that it has reached its ninth edition and has been translated into English, Russian and French. This success is well deserved. Within a comparatively small compass it gives a remarkably comprehensive oversight of the fundamental principles and of the important compounds of organic chemistry. The most important change in this edition is the addition of a third division called 'Heterocyclic Compounds,' though a considerable portion of the material in this division was formerly given under the division called 'Benzene Derivatives,' but in this edition named 'Isocyclic Compounds.' The aliphatic compounds are still called 'Methane Derivatives,' as in former editions.

On p. 70 Schorlemmer's classification of paraffins as normal, iso-, meso-, and neoparaffins is still given, although the last two classes are never mentioned in current literature and have been practically forgotten by most organic chemists. It is a pity we have no means of eliminating unnecessary and little used terms of this sort.

The most characteristic and valuable features of the book are the clear, concise statements given at the introduction of each new class of compounds, presenting the most important methods of preparation for the class and the facts on which our knowledge of the structure of the characteristic group of the class is based. The fault of the book, if it has one, lies in the brief description of an excessive number of compounds, far beyond the possibility of memory for any one. The effect must be bewildering and discouraging to the beginner. W. A. Noyes.

DISCUSSION AND CORRESPONDENCE.

AN UNUSUAL METEOR.

To the Editor of Science: On page 151 of your issue for August 3, Mr. E. E. Davis, of Norwich, N. Y., describes a very interesting meteor train observed by him about 5:30 or 6 P.M., when traveling between Cortland and Elmira, N. Y. The changes in his own location during the fifteen minutes must have had an appreciable influence on the appearance of this trail, but will scarcely alter our general conclusion that it was a typical case illustrating and settling a matter that has caused a little speculation among students of the subject. If a meteor leaves a visible train behind it we are apt to think that this is a series of luminous particles, lying in a straight or gently curved line, and that they will, by reason of unequal gravity, resistance of the air and possibly winds in the upper atmosphere, drift along unequally, so that the straight trail may gradually become irregular. This may be true in some cases, but it is incredible that any plausible movement in the thin upper air should affect the course of the scattered luminous particles. They must be considered as moving, with rapidly diminishing velocity, under the influence of three forces—namely, their initial momentum, the attraction of gravitation and a very gentle resistance from the atmosphere. In most cases the initial momentum is mainly that due to the straight-line motion of the original meteor; but in some cases this meteor may be revolving on its axis in a manner quite analogous to the less rapid rotation of a comet's nucleus, and just as the comet of 1875 sent out a series of tails from its revolving nucleus, so with the streams of material issuing from these rapidly revolving meteors. The diagrams submitted by Mr. Davis would indicate that five rotations were made in that portion of its track represented by his third curve; the motions of the particles outward from the meteor's track were so slow that it made a barely appreciable sine curve, or a broadening of the track, in his first and second curves, but a very large jagged sine curve in his sixth, or last, curve. This latter broadening re-

quired ten minutes of time, and if we had exact measurements of angles and times we should undoubtedly from these curves be able to deduce the rate of rotation of the meteor, and possibly its mass.

Most of the aerolites that come to the earth show, by their pitted surfaces, that the meteoric material is being split off or ejected quite uniformly from the whole surface; but some meteors, like some comets, may have only a very few regions on the surface from which material is ejected with any special force. In Mr. Davis's meteor of October 13 we seem to have a case in which some one spot on the side of the meteor, namely somewhere between its head and its tail, ejected its material freely and with considerable force, in a direction at right angles to the axis of rotation, or the line joining head and tail: it represents the rare case of a symmetrical revolving meteor.

CLEVELAND ABBE.

WASHINGTON, D. C.,
August 15, 1906.

SOME 'DEFINITIONS' OF THE DYNE.

IT would seem comparatively easy for any one whose mind has dwelt comprehendingly upon the relation $F = ma$ to define correctly the unit of force in terms of mass and acceleration. But such is evidently not the case. Of the text-books of physics immediately at hand, four give incorrect definitions of the dyne. In each case the author is a man of high and wide reputation as a writer and teacher. In quoting the definitions in question, I have taken the liberty of italicizing the words to be omitted with advantage.

(*a*) Force: dyne. 1 g. given unit acceleration *in 1 sec.*

(*b*) The practical unit of force is the dyne. * * * It produces unit acceleration of unit mass *in unit time.*

(*c*) The absolute unit of force (in the C. G. S. system) is called a dyne, and is that force which *in one second* is capable of giving to a gram-mass an acceleration of one centimeter per second.

(*d*) The absolute unit of force is the force that, acting *for unit of time* upon unit of mass, will produce unit of acceleration. * * * The centimeter-gram-second (C. G. S.) unit of force is the force that, acting *for one second* upon a mass of one gram, produces an acceleration of one centimeter per second. It is called a dyne.

The first two books are intended for universities and colleges, the latter two for preparatory schools, and all four, I believe, have been widely used.

It is perhaps proper to state that each of these authors gives a correct definition in terms of mass, time and change of velocity, but each seems implicitly to ignore the fact that acceleration is not change of velocity, but is *rate* of change of velocity. To conclude, the dyne is the force that, acting on a mass of one gram, gives to it C. G. S. unit acceleration (for which there is no name), irrespective of the time during which the force acts upon the mass, whether it be the millionth part of one second, or one million eons. $F = ma$, and when $m = 1$, and $a = 1$, then $F = 1$.

Similar errors are of course committed in defining the poundal. The text from which the quotation (*d*) above is taken gives:

> The foot-pound-second (F. P. S.) unit of force is the force that, applied to one pound of matter *for one second*, will produce an acceleration of one foot per second. It is called a poundal.

And a fifth book, also for preparatory schools, states:

> In the F. P. S. system the unit is the poundal, which is the force that on being applied to 1 lb. of matter *for 1 sec.* will give to it an acceleration of 1 ft.

In this last case, the same mistake is made in the general definition of the absolute unit of force, but the dyne, specifically, escapes with a defective definition in terms of mass, time and change of velocity.

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SPECIAL ARTICLES.

A PECULIAR MUTATION OF THE PINE MARTEN.

A TRAPPER'S skin, without skull, of a pine marten (*Mustela americana actuosa* Osgood) recently offered for sale to the National Museum by Mr. James Aitchison, Nulato, Alaska,

differs strikingly from any marten skin in the museum collection, or elsewhere, so far as I am aware. The long bristly hairs are everywhere lacking on the skin, which bears about the same relation to a normal marten that a plucked beaver or seal skin does to an unplucked one. Coues[1] describes the pelage of the marten as consisting of three kinds of hairs:

> The first is very short, soft and wool-like * * * the second soft and kinky, like the first but very much longer, coming to the general surface of the pelt. The third is the fewer, still longer, glossy hairs, bristly to the roots.

The specimen in question entirely lacks the long glossy hairs, and possesses a very few only, of Coues's second variety of hairs, with soft kinky base and short bristly tip. The entire pelage is practically composed of the soft short underfur. The general color of the skin is not abnormal; the head, chest, legs and feet are perhaps a little darker brown than the usual run of skins. The general size and proportion of the skin differ in no way from that of a normal marten.

Marcus W. Lyon, Jr.

AN OBJECT-FINDER FOR THE MICRO-PROJECTION APPARATUS.

No doubt every one who has undertaken to project the image of a microscopic preparation directly upon a screen for class or lecture demonstration purposes has realized the difficulties in the way of rapid and accurate location of the exact part of the object desired. Indeed, this method of illustration is at present seldom made use of, owing chiefly to the great loss of time involved, and to the distracting effects upon the attention of the class or audience.

Some time ago the writer devised an attachment for the micro-projection apparatus which so effectually overcame the difficulties mentioned above as to render this method of demonstration quite as expeditious and precise as that with ordinary photo-micrographic or other lantern slides. With this condition assured, the advantages of the method are obvious. Inquiries regarding this apparatus have led to the belief that the publication of a description of it may be worth while. The following description and the accompanying figures represent the latest improved form of the attachment.

As indicated in the figures, this attachment consists of a rotary object stage and a secondary, short-range projector, mounted on the same base-board with the usual projection apparatus. The light is taken from the electric arc, or other illuminant, *L*, of the main projector, through the opening at the side of the hood. In place of the blue or purple glass commonly found in this opening, there is put a simple collimating lens. The parallel emergent rays are reflected by the mirror, *A*, into the line of the optical axis of the finder, which is parallel to that of the projector proper. By means of the condenser, *B*, these rays are brought to a focus at the position of the object on the revolving stage *C*. A good hand lens at *D* projects an image of the object upon the small screen, *E*, which need not be more than about thirty inches from the object. The plan of the base-board, Fig. 2, will make clear the arrangement of the parts.

Fig. 3 shows the plan of the rotary stage-plate, with four openings and spring clips for holding the slides in position. Fig. 4 represents a face-view of the screen, *E*, which has a dead-white surface, with the two centering lines in black. All the parts are mounted on telescoping pillars, and are made adjustable in position on the base-board.

The rotary stage-plate requires special care in its construction and mounting, as it must be both accurate and rigid. Fig. 5 shows the details of the mounting. On top of the heavy pillar is the sleeve, made from thick-walled brass tubing. On the ends of the sleeve are the two collars, *b* and *c*. Working in the sleeve is the shaft, which is held in position by the collar *a* and the nut *n*. The plunger, *p*, actuated by the spring, *s*, passes through the collars, *b* and *c*, and engages the collar *a*. Four holes are drilled in the collar *a* for the plunger, and these holes must be exactly

[1] 'Fur-bearing Animals,' U. S. Geol. Survey, Miscell. Pub., No. VIII., 1877, p. 82.

ninety degrees apart. The stage-plate, *f*, is screwed firmly to the shaft and collar *a*, with the stage-openings precisely in the same radii with the four holes in the collar *a*.

ject which is now centered in the finder will be centered when rotated into the axis of the projector. Hence, while the first object is being projected on the large screen, the op-

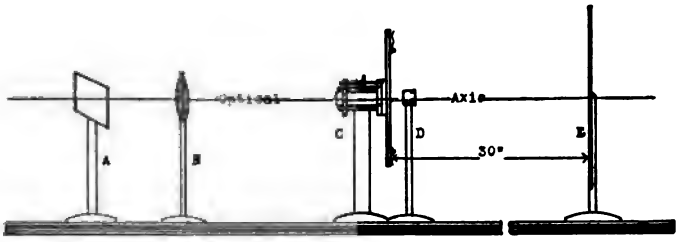

FIG. 1. Side Elevation

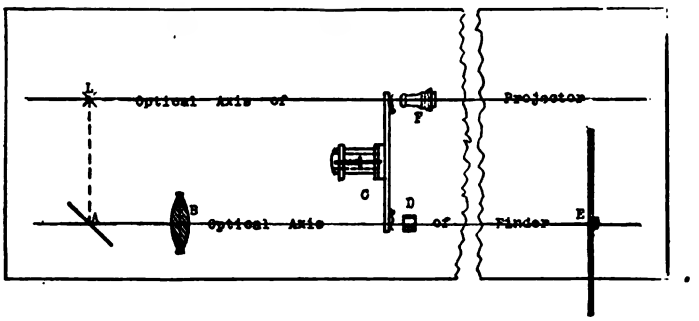

FIG. 2. Plan of base level.

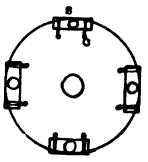

FIG. 3.

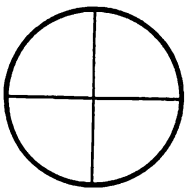

FIG. 4.

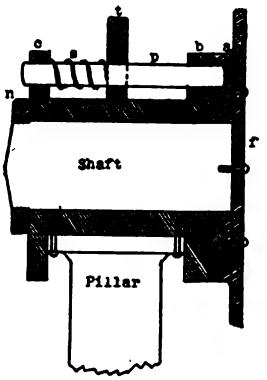

FIG. 5.

To operate the finder, it is first made par central, as follows: A slide bearing fine cross-lines, such as a stage micrometer, is accurately centered under the objective, *F*, of the projector. Then the stage is rotated 180°, and, without moving the slide, the image is brought to center on the screen *E* by adjusting the lens *D* and the screen *E*. Evidently, any operator may be finding the part of the third object which he wishes to show, the second having been located already. When the second is to be thrown upon the screen, the plunger is disengaged by means of the thumb-block *t*, and the stage is rotated 90°, when the plunger automatically locks the mechanism in the proper position. Slides of uniform thick-

ness are used in mounting objects for projection purposes, so that the projector may be brought to the proper focus with the least possible delay.

To secure the best results it is evident that the rotary stage must be accurately and rigidly built, in order to secure precise double centering of the object, and freedom from vibration.

Amon B. Plowman.

Pittsburg, Kans.

HELIUM IN NATURAL GAS.

Some three years ago a strong flow of natural gas was struck at Dexter, Kans. Upon the first attempt to utilize this, it was found that it would burn with difficulty and that only in previously heated enclosed space. Experience has so far improved the method of handling the gas that at the present time it is being successfully used for burning brick. The whole difficulty is due to the fact that it contains only a little over fifteen per cent. of combustible constituents. The first publication upon this gas was a paper by Haworth and McFarland, Science, Vol. 21, p. 191, in which they reported that it contained in addition to a large amount of nitrogen some inert residue.

We have taken up the further investigation of this gas and at the New Orleans meeting of the association Dr. E. H. S. Bailey reported for us that it contained 1.84 per cent. of helium. The occurrence of such a large percentage of helium in one of the gases of the Kansas field has led us to the examination of others. Up to the present time we have investigated some twenty samples from the most widely separated points of this field and have found helium in every case, but always in much smaller amounts than at Dexter. From the latter gas, we have with the aid of liquid air extracted a very fair amount of helium.

Accompanying the determination of helium, we are making complete analyses of the gases and shall have within a short time results from thirty to forty samples covering in detail the entire Kansas field as at present developed—an area of some twelve thousand square miles. The rather large number of analyses is required because the gas is extremely varied in its character. This is illustrated by the fact that the wells at Arkansas City, less than twenty miles from Dexter, yield more than 97 per cent. of combustible gases and only .16 per cent. of helium as compared with 15 per cent. and 1.84 per cent., respectively, for these constituents in the Dexter gas. Samples are also being obtained from the other fields of the country and the results from these will be included in a detailed paper to be published soon.

As the gases are run through the analyses spectral tubes are filled, and various residues and fractions are saved with the intention of subjecting them to a detailed spectroscopic examination. Some work of this kind has already been done.

We feel that we have here a very unusual opportunity for obtaining helium in practically unlimited quantities, and as we have worked out the details for its separation we shall have a large amount prepared and will attempt its liquefaction. While the necessary preparations are in progress we shall devote ourselves to the spectroscopic work above mentioned.

Hamilton P. Cady,
David F. McFarland.

The University of Kansas, Lawrence,
July 12, 1906.

CURRENT NOTES ON METEOROLOGY.

DR. HANN AND THE 'METEOROLOGISCHE ZEITSCHRIFT.'

The fortieth anniversary of Dr. Hann's assumption of the editorship of the *Meteorologische Zeitschrift* was fittingly observed by the publication of a special number of that excellent journal, to which friends and colleagues contributed articles. The 'Hann-Band' numbers 404 pages; contains 42 papers by as many different writers, and has as a frontispiece an engraved portrait of Dr. Hann. An appropriate introduction, by Pernter and Hellmann, refers to the remarkable work which Hann has done for his science in the *Zeitschrift*. Among the papers, all of which are of immediate importance, the following are of most general interest: Paul Schreiber:

'Untersuchung über die Genauigkeit der Tages-, Monats- und Jahresmittel aus den Temperaturbeobachtungen für die drei Stunden-Kombinationen: 6 A.M.–2 P.M.–10 P.M.; 8 A.M–2 P.M.–8 P.M.; 7 A.M.–2 P.M.–9 P.M.' Dr. Schreiber is at the head of the Meteorological Institute of Saxony, and is well known through his accurate statistical work there. H. H. Hildebrandsson: 'Sur la Circulation des Couches supérieures de l'Air au dessus du Maximum de l'Atlantique Nord.' Dr. Hildebrandsson, as is known to readers of these notes, has lately advanced a new view of the general circulation of the atmosphere, and all his contributions to this subject are of peculiar interest. A. Woeikof: 'Die Verteilung und Akkumulation der Wärme in den Festländern und Gewässern der Erde.' Woeikof has given special attention to the larger relations of land and water and climate; this is a study in this connection. W. N. Shaw: 'The Law of Sequence in the Yield of Wheat for Eastern England, 1885–1904.' In this paper the director of the British Meteorological Office gives the results of his recent studies into the relations of weather and the wheat crop in England. L. Teisserenc de Bort: 'Sur la Circulation générale de l'Atmosphère,' an investigation of the relations between temperature and pressure at sea-level and in the free air. Cleveland Abbe: 'The Trade Winds and the Doldrums,' being notes on observations made by Professor Abbe during a voyage in the U. S. S. *Pensacola* in October, 1889, and May, 1890. A. L. Rotch and L. Teisserenc de Bort: 'The Meteorological Conditions above the Tropical North Atlantic,' dealing with results already summarized in these notes.

ANTI-TRADES IN CENTRAL AMERICA AND THE WEST INDIES.

A BELATED note on the drift of the upper air currents as shown by the carriage of smoke and ashes during the volcanic eruptions of 1902–3 in the West Indies and Central America is found in the *Meteorologische Zeitschrift* for July. The writer, Dr. K. Sapper, points out that but little attention has yet been paid to this subject. The anti-trade in the West Indies was clearly evidenced by the drift of smoke and ashes from St. Vincent and from Mont Pelée. The altitude of this upper current is not great, but was not accurately determined. In Central America the anti-trade seems to occur, if at all, at very great altitudes. Observations of the drift of smoke and ashes at heights of 7,000 to 8,000 meters above sea-level showed a movement towards the west or north-northwest. There was a slight carriage of ashes in an easterly direction, but of no considerable importance. The famous eruption of Coseguina, in 1835, showed that in southern Central America, at any rate, the anti-trade blows from west-southwest. Ashes fell in Jamaica. Smaller eruptions of other volcanoes in 1880, 1864, 1828 and 1833 showed a westward drift of the upper currents.

RAINFALL, TEMPERATURE AND TREE GROWTH.

IN the *Bulletin of the American Geographical Society* for July, Mr. Henry Gannett discusses 'Certain Relations of Rainfall and Temperature to Tree Growth' in the western United States. He finds that the timber-line has a mean annual temperature of approximately 30°, but the data relating to rainfall are more definite and more significant than those of temperature. It appears that the lower limit of the yellow pine is at or just below 20 inches of rainfall. The lower limit of the red fir is at or about 30 inches, and there is apparently no upper limit, the fir being abundant where the rainfall exceeds 100 inches a year. The redwood belt in California includes only one station with a rainfall less than 30 inches. This seems to show that the isohyetal line of 30 inches is the lower limit of this species.

CUMULUS CLOUDS OVER THE SAN FRANCISCO FIRE.

WE have seen but one notice of the development of cumulus clouds over the fire which followed the San Francisco earthquake. This is in a letter from Mr. Charles Van Norden (*Nature*, Vol. 74, 1906, p. 133), who observed the conflagration from the deck of a ferry boat. A white cumulus cloud was seen, dark

at the bottom, hanging over the city. The morning was clear and mild, and no other cloud was in sight. Cumulus clouds over fires have frequently been observed, and they have several times received mention in these columns (see SCIENCE, V., N. S., 1897, 60–61, for a good illustration of a cumulus cloud thus formed).

R. DEC. WARD.

HARVARD UNIVERSITY.

PROPOSED UNION OF MEDICAL SOCIETIES IN LONDON.[1]

A MEETING of the General Committee of Representatives of Medical Societies in London was held on July 17 to consider the report of the organizing committee.

Sir William Church, who was in the chair, pointed out that at the first meeting of the members of societies, which was held at the Royal College of Physicians in 1905, the feasibility of union was considered, and that as the outcome of the opinions expressed at that meeting a committee of representatives of the various societies was appointed. The committee of representatives appointed an executive committee to go more thoroughly into the feasibility of union and to outline some scheme of union if such were thought possible. This executive committee reported that a union was feasible on certain lines, and its report was confirmed by the committee of representatives on July 19, 1905. With that report the executive committee's work came to an end, and an organizing committee was appointed to draw up a definite and, as far as possible, a detailed scheme of union. This scheme was before the meeting, and if approved would be sent to the societies to act upon or not as they thought fit. Those societies which approved of the report and decided to join the proposed union would be asked to appoint a representative before December 7 next to sit upon a committee which would act as the first council of the new society and deal with the necessary details of amalgamation.

The report recommended that all male members of those societies which took part in the amalgamation should be permitted to join the new society on its formation as members or fellows without election, and that all women members of a society taking part in the amalgamation should become members of the corresponding section or sections of the new society. It was further recommended that the society should consist of the following sections which represented existing societies, but that the new society should have power to add new sections:

1. Anæsthetic.
2. Balneological and Climatological.
3. Clinical.
4. Dermatological.
5. Diseases of Children.
6. Electro-Therapeutical.
7. Epidemiological.
8. Laryngological.
9. Life Insurance.
10. Medical.
11. Neurological.
12. Obstetrical and Gynæcological.
13. Odontological.
14. Ophthalmological.
15. Otological.
16. Pathological.
17. Surgical.
18. Therapeutical.

It was hoped that in the early future an anatomical and physiological section and a section of preventive medicine might be formed. The Medico-Psychological Association and Medico-Legal Society hoped to join the new society at some future date. It was recommended that each section should be self-governing as far as possible, and should have direct representatives on the council of the society and on the editorial committee, but that its expenditure should be subject to the control of the finance committee of the general council. The general management of the society would be under the control of a general council consisting of the president, the presidents of the various sections, two treasurers, two librarians, two secretaries and eight other fellows.

[1] From *The British Medical Journal.*

CHEAPER LIQUID AIR.

ACCORDING to a consular report recent experiments in England of an invention by Mr. Knudsen, a Dane, furnished liquid air at

one sixth of the present market price, and give promise of an ultimate low price of a fraction over two cents per gallon. The result is secured by purely mechanical means, without an atom of added chemicals. Atmospheric air is first purified and then compressed by stages to 2,500 pounds to the square inch. It is finally reduced to 125 pounds to the square inch, which then cools and liquefies the high-pressure air. The oxygen gas produced by separating the nitrogen from the liquid air is claimed to be purer than that of the old method, and can be supplied in the liquid as well as in the gaseous form. One gallon of liquid air equals approximately 128 cubic feet of oxygen gas, which retails at six cents per cubic foot. The new price is one cent. Liquid air has been successfully used in coal as an explosive, being quite safe where fire damp and other explosive gases exist. Liquid oxygen is also used for welding steel pipes, boiler shells and plates for shipbuilding instead of riveting. That oxygen and nitrogen can be separated from liquid air and sold retail at $1.20 per gallon shows great commercial possibilities. The use of nitrogen for agricultural purposes opens yet another field. The maturing of liquors will be helped by liquid air, as also the preservation and purification of milk. As a motive power its use is considered to be quite practicable for small powers. The British government is already carrying out a number of experiments with a view to the utilization of liquid air for various purposes.

RADIUM.[1]

I venture to think that the thanks of the public are due to Lord Kelvin for his timely and outspoken protest against the conclusion being drawn, from the evidence at present before us, that it is proved that there is a 'gradual evolution of one element into others.' No one has yet handled 'radium' in such quantity or in such manner that we can say what it is precisely. That helium can be obtained from 'radium' appears to be proved; but no proof has yet been given that it is not merely contained in it. As I remarked at York last week, physicists are strangely innocent workers; formulæ and fashion appear to exercise an all-potent influence over them. There was a time when the expression 'scientific caution' meant the highest degree of caution, and it was supposed to be the attribute of workers in science. Workers in the radium school appear to have cast caution to the winds and to have substituted pure imagination for it. Among ourselves, we should always be at liberty to postulate the most crack-brained of hypotheses, to dream the wildest of dreams, as a means of guiding inquiry; but we should not court popularity on such a basis. By so doing we lose all claim to guide public opinion.

HENRY ARMSTRONG.

I am glad to have contributed towards eliciting Lord Kelvin's views on this subject. Those interested will no doubt judge for themselves whether or not the precautions adopted by Ramsay and Soddy, Himstedt and Meyer, and Curie were such as to make it certain that helium is continuously evolved from radium, as those writers supposed.

As to the internal heat of the earth, Lord Kelvin quotes the generally accepted conclusion that the life of radium is limited to a few thousand years. From this he argues that the radium now in existence has not been there long enough to heat the earth to its present high internal temperature. To this I reply that it is true that the actual radium now in existence has not done the work throughout, but that the supply of radium in the earth is maintained at a constant level by the production of fresh radium by uranium, contained in a small proportion in the rocks. Lord Kelvin, anticipating this reply, expresses his dissent from the view, current among workers on radioactivity, that radium is continuously produced by uranium. I should like to ask a simple question. Lord Kelvin disbelieves that radium is being generated from any parent substance. How does he explain the existence of radium in the earth at present? On his own showing the identical radium now existing has not been there long. Is he prepared to assume that it was miraculously created in comparatively recent times?

R. J. STRUTT.

In your yesterday's issue I see letters of Sir Oliver Lodge and Mr. R. J. Strutt, replying to

[1] Correspondence in the London *Times*, called forth by a letter from Lord Kelvin, reprinted in the issue of SCIENCE for August 24, p. 255.

my letter to you of August 9 regarding radium.

After a kind personal reference to myself, Sir Oliver Lodge says, "but it is also known that" Lord Kelvin's mind "has not always submitted patiently to the task of assimilating the work of others by the process of reading, and our hope has been that before long he would find time and inclination to look into the evidence more fully." I am quite sure my old friend Lodge could not wilfully be unjust to me, but I do not think he knows how carefully and appreciatively I have done all I could by reading, and by personal intercourse with many of the chief workers in the field, to learn experimental results and theoretical deductions regarding radioactivity, ever since its discovery ten years ago by Henri Becquerel. I scarcely think any other person has spent more hours in reading the first and second editions of Rutherford's 'Radioactivity' than I have.

Both Lodge and Strutt refer to the slowness of the extraction of helium from radium, in the process hitherto followed; and there seems to be good reason to believe that this slowness is essential. Strutt says, "If all helium has been removed from a sample of radium, it is found that, after an interval, a further supply can be extracted." The last clause shows that the initial 'if' was wrong; and that some helium remained in the modified sample of radium. This view is thoroughly in accordance with Rutherford's second edition (1905), p. 284, in which it is suggested that 'uranium, thorium and radium are in reality compounds of helium'; and, more particularly, that radium (atomic weight 225) may be a compound of four atoms of helium (atomic weight 4×5) and one atom of lead (atomic weight 205).

As to the suggestion, made first, I believe, by Sir George Darwin about three years ago, and favorably received by Rutherford, Strutt and others, that our present underground heat, and sun-light and sun-heat are due to radium, I must, for the present, limit myself to two sentences: (1) Radium alone is quite insufficient, its duration as a source of energy being estimated by Rutherford (2d edition, p. 458) as not more than a few thousand years ('the average life of radium is 1,800 years'). (2) The suggestion that in uranium, thorium, actinium and other matter capable of being 'transformed slowly into radium,' we have at least a million times as great a store of energy as we may think we have in radium, practically available for sun-heat and underground heat, is not validly supported by any experimental evidence hitherto published.

KELVIN.

Your leading article (August 18) and recent correspondence show that an emphatic statement is needed to make clear to your lay readers:

(1) That radium is not an ordinary chemical compound.

(2) That it does disintegrate with explosive violence.

(3) That it is present in sufficient quantity to account for the heat of the earth.

(4) That its disintegration is not altered by any known physical conditions.

Some experimental results obtained by me last spring at Montreal, under the guidance of Professor Rutherford, are in good agreement with those found independently and by a different method by the Hon. R. J. Strutt. The equivalent amount of radium present in the upper layers of the earth was determined by the penetrating radiation resulting from the active matter. An account of this work has been communicated to the *Philosophical Magazine* and is in the printer's hands.

It is certain that radium does occur in sufficient quantity, and that its heat energy is of sufficient magnitude, to account for the existing temperature-gradients of the earth. Until we can conduct experiments in the interior of the earth, the radium theory is entitled to at least as much weight as the gravitation theory.

The recent discussion in your columns has resulted in a goodly crop of errors, written by those who have contented themselves with reading rather than with research work. I believe that no actual worker at the subject dissents from the general conclusions contained in Rutherford's 'Radioactivity.'

For example, it has been implied that radium is merely an ordinary compound of lead (?) and helium. But no ordinary chemical compound projects a particle, having the mass of a helium atom, with a velocity almost of the order of the velocity of light.

It has been stated that the disintegration of radium occurs too slowly to be detected by direct observation, and that is true. But some of the other active bodies, such as the subsequent products of radium, disintegrate with no less violence in a few minutes. It has been suggested that the disintegration may be retarded by pressure or by lack of concentration; but all the evidence—and there is much—indicates that the process of disintegration can neither be accelerated nor retarded by temperature, pressure, concentration, or other physical changes.

It is to be hoped that reverence for a great name and an honored veteran will not induce your readers to regard lightly the brilliant and remarkable series of recent scientific discoveries in radioactivity. A. S. EVE.

SCIENTIFIC NOTES AND NEWS.

DR. JOSÉ DE AGUILAR, director of the Mexican Geological Survey, has been elected president of the International Geological Congress, which met last week in Mexico City.

SIR DAVID GILL, astronomer royal at the Cape of Good Hope and president-elect of the British Association for the Advancement of Science, has been elected a foreign member of the Accademia dei Lincei, Rome.

DR. OTTO BÜTSCHLI, professor of zoology at Heidelberg, has been elected a foreign member of the Brussels Academy of Sciences.

IN connection with the celebration of the quater-centenary of the foundation of the University of Aberdeen, the University of St. Petersburg has conferred its honorary membership on the lord rector, Sir Frederick Treves, the eminent surgeon and anatomist.

DR. EDOUARD ZELLER, the eminent writer on the history of philosophy, celebrated on August 25 the seventieth anniversary of his doctorate.

DR. JOHANN RANKE, professor of anthropology and general natural history at Munich, has celebrated his seventieth birthday.

PROFESSOR R. B. DIXON, of Harvard University, has completed an ethnological and philological exploration of the Chimariko Indians of California in connection with the Ethnological and Archeological Survey of California. The Chimariko constitute the Indian stock which is nearest to extinction of the many in California, and Professor Dixon found only four or five survivors. He was able to obtain particularly full information as to the language.

MAJOR RYDER, R.E., who had charge of the expedition to Gartok and western Tibet after the capture of Lhasa, has returned to India, where he has been appointed superintendent of the northern circle of frontier surveys.

THE annual course of Lane medical lectures was given in Cooper Medical College, San Francisco, by Dr. John McVail, Glasgow, Scotland, on August 20 and the five following days. The general subject of the lectures was 'The Prevention of Infectious Diseases.'

DR. G. WOOBERMIN, who has recently been called from Berlin to an associate professorship at Marburg, will give a course of lectures at Yale University on 'German Culture in the Nineteenth Century.'

WE have already noted the movement in Germany to raise a memorial fund for the benefit of the widow and children of the late Dr. Schaudinn. We learn from *Nature* that an English committee consisting of Professor Clifford Allbutt, F.R.S., Sir Michael Foster, F.R.S., Mr. Jonathan Hutchinson, F.R.S., Professor Ray Lankester, F.R.S., Sir Patrick Manson, F.R.S., Professor Osler, F.R.S., Mr. John Tweedy and Professor Sims Woodhead has been formed to cooperate with the German promoters of the scheme. Subscriptions may be paid to Mr. Adam Sedgwick, F.R.S., treasurer of the fund, New Museums, Cambridge, or direct to the Schaudinn Memorial Fund at Messrs. Barclay and Company's Bank, Cambridge. American subscriptions would doubtless be welcome.

DR. H. MARSHALL WARD, F.R.S., professor of botany at Cambridge University, died on August 26, aged fifty-two years. Professor Ward, who was educated at Owen's College and Cambridge University, was for a time cryptogamic botanist to the Ceylon government; in 1883 he was elected to a fellowship at Christ's College at Cambridge, and after working as professor of botany in Forest School, Coopers Hill, from 1885 to 1895, he succeeded the late Professor C. C. Babington as professor of botany in Cambridge University. Dr. Ward was the author of works on the diseases of plants, and especially of timber trees.

DR. ALEXANDER HERZEN, professor of physiology at Lausanne and the author of numerous contributions to this science especially con-

cerned with the physiology of digestion, died on August 24, at the age of sixty-seven years.

Mr. Charles Barron Clarke, F.R.S., for many years inspector of schools in Bengal and the author of numerous contributions to botany and other natural sciences, died on August 25, at the age of seventy-four years.

We regret also to note the following deaths among foreign men of science: M. Albert Tissandière, who like his brother, the late Gaston Tissandière, was known for his researches in aeronautics; Mr. James Dredge, since 1870 one of the editors of *Engineering* and the author of works on electrical illumination, the Columbian Exposition and other subjects; Dr. Carl Thon, docent in zoology at Prague; Mr. Robert Philips Greg, who many years ago was known as a leading mineralogist, and M. Georges Salmon, leader of the French scientific mission to Morocco.

General E. P. Walker has bequeathed his library and collection of manuscripts and $30,000 to the Lloyd Library of Botany and Pharmacology, at Cincinnati.

There will be established at Bagatelle, near Paris, a 'Jardin des Fleurs,' which will include a botanic garden, a museum and laboratory.

There will shortly be held at Paris an international conference on the selection and introduction of useful plants.

The German Society of Dentists has received a bequest of 10,000 Marks from the late Dr. Adolf Witzel, professor of dentistry at Bonn, to promote the study of this subject at the German universities.

According to a press despatch from Washington, the Department of Agriculture is preparing for the increased labor and equipment involved in the enforcement of the new pure-food law, which goes into effect on January 1, next. The forces and appliances of the laboratories at Philadelphia, Chicago, Baltimore and New Orleans will be largely increased, while at New York and Boston new laboratories will be erected in which to conduct the necessary examinations of food products coming into the country. Plans for the buildings in New York and Boston have been approved by Dr. H. W. Wiley, chief of the Bureau of Chemistry. There is no money available for the construction of the buildings, but the secretary of agriculture has been assured that it will be forthcoming at the next session of congress. Assurances have been given that the money necessary to enforce the new law, through the employment of inspectors and the clerical force, will also be provided.

We learn from the London *Times* that in view of the spread of sleeping sickness in Africa and of the fact that an expedition organized by the Liverpool School of Tropical Medicine has been studying this disease for three years in the Congo, Sir Alfred Jones, president of the school, requested an audience of the King of the Belgians in order to confer with him upon the subject. In a recent letter to the secretaries of the reform committee King Leopold referred to his deep interest in this matter, and, besides offering a prize of 200,000f. for the person who should discover a remedy, he has placed a credit of 300,000f. in the Congo estimates for the purpose of prophylactic research. The committee of the school was received by King Leopold on August 23. The representatives present included the president, Sir Alfred Jones, Professor Ronald Ross, C.B., F.R.S., Professor Boyce, F.R.S., Dr. J. W. W. Stephens, Dr. J. L. Todd, Mr. R. Newstead, Dr. Evans and Mr. A. H. Milne. The king gave a most attentive hearing to the views of the experts of the school, and asked for a scheme for the prevention of the disease. He has promised his cooperation if it is in any way feasible. In conclusion, to show the value he placed upon the work of the school, he bestowed the Order of Leopold upon Professor Ross, Professor Boyce and Dr. J. L. Todd, the last-named of whom worked on trypanosomiasis in the Congo Free State for three years. The conference was followed by a luncheon at the palace.

The Journal of the American Medical Association states that the subject announced by

the medical faculty at Berlin for the essays in competition for the royal prize is: 'Comparative Research on the Histogenesis of the Heart Musculature.' The subject for the city prize essay is: 'Research on the Normal and the Pathologic Anatomy of the Appendix.'

FOREIGN journals state that the Australian government has issued a proclamation prohibiting the importation of the microbe of hæmorrhagic septicæmia, by which it was proposed to destroy the rabbit pest, except upon the condition that the packages containing the microbes be handed unopened to the state bacteriologist of New South Wales, and retained by him unused until the minister gives permission to use them. Under the Noxious Microbes Act of 1900 of New South Wales it will also be necessary for the state government to pass a regulation sanctioning experiments before anything can be done in the way of rabbit extermination. In the meantime only laboratory experiments will be carried on.

A ROYAL commission has been appointed "to inquire into the existing system of management of the lights, buoys and beacons on the coast of the United Kingdom by the three general lighthouse authorities, and as to the constitution and working of these authorities, and to report what changes, if any, are desirable in the present arrangements."

THE American Institute of Social Service will hold in New York City, in January next, an exposition of devices for safeguarding the lives and limbs of working men and women, and for preventing accidents under the ordinary conditions of life and labor to which the general public is exposed. The interest of manufacturers generally is solicited, as well as that of organizations whose special function is to improve the conditions of labor, and a widespread response is looked for to this request for representation in the nature of photographs, descriptive drawings, models, and, as far as possible, the devices themselves in actual operation. Following are some of the groups of exhibits: Section 1. Models, photographs and drawings of scaffolding, as well as the personal equipment of workers in building trades. 2. Protective devices for boilers, water gauges, signal apparatus, boiler and pipe valves; also protective devices for electrical machinery and acetylene apparatus. 3. Protective devices for motors and power transmitters, devices for turning on power and shutting it off, belt connection, couplings, etc. 4. Fire protection and the prevention of explosives. 5. First aid to the injured. 6. Mining and quarrying; devices in use on stone-crushing machinery, etc. Storing of explosives. 7. Metal industry; safety devices for metal-working machinery. 8. Textile industry: safety devices for looms, carding, etc. 9. Leather and paper industry: safety devices for paper cutting, stamping and molding machinery. 10. Safety appliances for elevators and hoisting apparatus models. 11. Food products: safety appliances for kneading machines, rollers and cutters. 12. Personal equipment of workingmen: protective spectacles, respirators, suits, etc. 13. Workingmen's dwellings. 14 and 15. Housing: models, plans, photographs. 16. Ventilation. 17. Models, photographs and plans of toilets, dressing and living rooms, baths, etc. 18. Cooking: demonstration in heating food; models, plans, photographs. 19. Other social betterment institutions; reports of labor departments, industrial arbitration courts. 20. Agricultural machinery: safety appliances on same, demonstrated by models and views. 21. Lumber industry: safety devices for band and circular saws, planing machinery, etc., demonstrated by models. 22. Models, photographs and plans of workingmen's industrial betterment institutions of all kinds. Requests for information regarding space should be made to Dr. William H. Tolman, director, 287 Fourth Avenue, New York.

UNIVERSITY AND EDUCATIONAL NEWS.

THE new buildings of the Harvard Medical School will be formally dedicated on September 25 and 26. On Tuesday afternoon exercises will be held at the new site, with

short addresses by Professors Warren, Dwight and Shattuck and Mr. Coolidge, the architect. In the evening a reception will be given at the Boston Medical Library. On Wednesday morning there will be exercises at Cambridge, which will include addresses by President Eliot and Professor Welch, of the Johns Hopkins University, and the conferring of honorary degrees. In the afternoon the triennial banquet of the Harvard Medical Alumni Association will be held in Memorial Hall.

THE Johns Hopkins University announces the establishment of advanced courses in applied science. They aim to present the most recent advances of the several sciences from the point of view of theory and in their special bearing on industrial applications, and are designed to meet the demand for a specialized scientific equipment exceeding that indicated by the usual collegiate or engineering degree. Particular attention will be paid to the results of research and to improvements in methods, as reported in the current scientific literature. Complete laboratory facilities are offered to engineers and others who desire to prosecute research along particular lines. The courses are intended for the following classes of students: (*a*) Graduates in engineering or science who wish to extend their equipment in special directions; (*b*) engineers desirous of knowing the present state and trend of research in their subjects; (*c*) those wishing to prosecute some special experimental research; (*d*) those wishing to attend special courses in applied science.

AN Italian-American educational alliance has been established for the exchange of lecturers and professors between the two countries and the improvement of their educational relations. The arrangements have been made in Italy by Dr. Joseph S. Kennard, who especially represented the University of Pennsylvania.

IT is reported that at the meeting of the Russian Council of Ministers, held on August 21, it was decided to appoint a commission to draw up a bill providing for universal primary education, to be submitted to the council of the empire and the duma at the beginning of the next session. The council also decided that it was imperatively necessary to increase the salaries of primary teachers and to build more schools, for which purpose it assigned a grant of 5,333,000 roubles, chargeable to next year's budget. A commission sitting under the presidency of the minister of education has recommended the reopening of the universities, under practically the same conditions as were vainly tried last autumn, an autonomous government by a professorial council.

PROFESSOR DUGALD C. JACKSON, head of the department of electrical engineering at the University of Wisconsin, has been elected professor of electrical engineering and head of the electrical engineering department in the Massachusetts Institute of Technology, as the successor of Dr. Louis Duncan, who resigned about a year and a half ago.

DR. THOMAS E. MCKINNEY, professor of mathematics and astronomy at Marietta College, has been called to Wesleyan University; Dr. Henry L. Coar, instructor in the University of Illinois, has been appointed assistant professor of mathematics in Marietta College, to succeed Professor McKinney.

THE University of Southern California at Los Angeles has made the following promotions and appointments: Miss Nelle Lancaster, instructor in biology, to become assistant professor of zoology; Edward A. Henderson, instructor in chemistry, to become assistant professor of pharmaceutical chemistry; Miss Florence E. Durkee (A.B. Stanford University), appointed fellow in botany.

DR. GUSTAV HAUSER, of Erlangen, will succeed Professor G. E. von Rindfleisch as professor of pathology at Würzburg.

DR. ROBERT WOLLENBERG, professor of psychiatry at Tübingen, has been called to a similar chair at Strasburg.

DR. LUDWIG RHUMBLER, of Göttingen, has been appointed professor of zoology in the School of Agriculture at Hanover.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ADDRESS BEFORE THE SECTION OF MATHEMATICS AND PHYSICS.

MY predecessors in this chair have in general been able to make communications to the section conveying the results of investigations of their own, or enunciating some principle which would throw a fresh light on the discoveries of others. Mine is a far less happy lot. During the past four years and a half I have been engaged in administrative duties of such a nature that no time has been available for personal scientific work, and little energy even for the study of the work of others. In these circumstances it might have seemed more fitting if I had refused the honor which the council of the British Association conferred upon me by the request that I would undertake the arduous duties which fall to the lot of the president of Section A. Nevertheless, after much hesitation, I decided to accept the invitation, in the hope that as a looker-on at the struggle of others, and with the experience of an old participator in the fray, I might be able to communicate some impressions which had possibly escaped the notice of those whose attention was necessarily more directed to some special branch of inquiry.

I trust that these words of apology may to some extent explain the nature of what must appear a fragmentary discourse.

In the interval which has elapsed since the last meeting of the association we have lost many men whose names were household

words within the walls of the physical laboratory. It is here only possible briefly to refer to the labors of a few of those distinguished seekers after natural knowledge.

The work of Dr. Sprengel has been by no means an unimportant factor in the advance of our knowledge of radiant energy, X-rays, etc., if only on account of the perfection of the apparatus for obtaining high vacua which will ever be associated with his name. The practical effect of his discoveries was considerable, for the business of electric lighting is undoubtedly greatly indebted to his labors. Born in 1834, he settled in England at the age of twenty-five. He was elected a fellow of the Royal Society in 1878, and resided in this country during the remaining years of his life.

The death of Charles Jasper Joly, F.R.S., at the early age of forty-one, robbed mathematics and astronomy of one of their most devoted disciples. His 'Manual of Quaternions' is well known, and those acquainted with his astronomical work are confident that, had his life been spared, he would, as astronomer royal of Ireland, have added luster to an office held by many distinguished predecessors.

Samuel Pierpont Langley was born in 1834. In 1866 he became director of the Allegheny Observatory at Pittsburg. His first work was the institution of a uniform system of time from the Atlantic seaboard to the Great Lakes. This, the first successful attempt to introduce uniformity of time over a large area, was subsequently widely imitated. In 1880 he invented the bolometer, and thus opened out a large new field of investigation into the invisible rays of long wave-length proceeding from heated bodies. He analyzed in minute detail the lunar heat spectrum, and, more recently, he conducted an inquiry into the nature of the radiations emitted by the glow-worm. In 1881 he conducted his researches into the solar heat of the earth's atmosphere. In 1887 he became secretary to the Smithsonian Institution. The result of twenty years' labor is to be found in the accurate determination, by temperature alone, of more than seven hundred lines in the invisible red spectrum, lines which are fixed with an average probable error of about one second of arc. In 1891 he published his experiments in aerodynamics, in 1893 'The Internal Work of the Wind' and in 1896 he demonstrated by actual experiment that a body nearly a thousand times heavier than air can be driven through and sustained by it. His published works show great literary charm. He especially excelled in the presentation of abstruse subjects in simple and non-technical language. This is, perhaps, hardly the occasion to refer to his social qualities. Those who had the privilege of his acquaintance, however, can best testify to his quickness of insight, his intense sympathy, especially with the young, and the impression of capability which he produced upon all with whom he came in contact.

The tragic death of Professor Curie was felt as a calamity, not only by those closely interested in the march of scientific discovery, but also by those who had but a superficial knowledge of his work. A teacher for more than twenty years, he was, nevertheless, enabled by his enthusiasm and energy to perform those researches which will ever be connected with his name and that of his wife. So entirely has public attention been attracted to their joint work on the separation of the compounds of radium and their properties that we are apt to overlook other great services he rendered to science. His paper on 'The Effect of Temperature on the Magnetic Properties of Bodies' led to the discovery of the

law that for feebly magnetic substances the coefficient of magnetism varies inversely as the absolute temperature. He also pointed out that the magnetization of diamagnetic substances appeared to be independent of the temperature and physical state, indicating diamagnetism as an atomic property.

It is pleasing to reflect that the importance of his discoveries received immediate recognition. It was but three years before his death that he announced to the French Academy the discovery of the new element, and in the same year he and Mme. Curie received the Davy medal of the Royal Society and the Nobel prize; and in July of last year he was elected to the French Académie des Sciences. He was one of the most modest and retiring of men, and this honor came to him unsought; his name will ever be remembered as one of the most notable of that brilliant band of workers who have within recent years so greatly extended the domain of physics by the discovery radioactivity.

A quarter of a century has passed since this section, meeting in this city of York, had the privilege of listening to a presidential address by the pioneer of natural knowledge whom we now know as Lord Kelvin, and it may possibly be a not unprofitable task to review briefly a few of the advances which must render the interval a memorable one in the annals of science. Lord Kelvin summarized the stores of energy from which mechanical effects can be drawn by man as follows: (1) the food of animals, (2) natural heat, (3) solid matter found in elevated positions, (4) the natural motions of water and air, (5) natural combustibles, (6) artificial combustibles.

The twenty-five years which have since elapsed have not made it possible to extend this list. It is true that within the last few years the discoveries connected with radioactivity have enormously increased our estimate of the stores of energy surrounding us, but so far these additional stores can not be regarded by us as stores from which 'mechanical effects may be drawn by man.' It is possible that in the ingenious radium clock which we owe to Mr. Strutt we have a source of mechanical energy unsuspected in 1881, but, at all events, regarded from a commercial standpoint, it can hardly be considered as 'available by man.' Nevertheless, there is a sense in which it may be said that we are profiting by atomic energy, for we are no longer bound to limit our estimate of the energy due to the radiant heat of the sun and the internal heat of the earth by previously known dynamical considerations, and, in consequence, our opinions with regard to the limit of the ages which the physicist could allot to the evolutionist have undergone profound modification.

I here wish to draw attention to some of the conclusions to which we are led by the work of Mr. Strutt.

Assuming the earth to be in thermal equilibrium, then, even if the whole of this interior heat be due to radium alone, the mean quantity per cubic centimeter can not much exceed 1.75×10^{-13} gram. The conclusions of Rutherford, based on somewhat different values for the constants involved, give an equivalent of 1.52×10^{-13}. Now Strutt has found that the poorest igneous rock examined by him, namely, Greenland basalt, contains more than ten times this quantity, and an average rock fifty or sixty times the amount. The assumption that the earth is cooling only aggravates the difficulty, and facts appear to tell against the theory that it is getting hotter. Also, we must take into consideration the heat due to the existence of uranium, thorium, etc.

We appear, therefore, to be driven to one of two assumptions: either (*a*) that the rate of heat production by radium diminishes as we approach the center of the earth; or (*b*) that the interior of the earth differs markedly in constitution from the exterior crust.

It is true that Mr. Makower has shown that there is a slight change of activity in one of the radium products about the temperature of 1,200° C., and it is very desirable that this inquiry should be pushed to much higher limits. At the same time, it appears evident that but a very slight change in activity takes place at temperatures below 1,500° C.

Now Mr. Strutt has shown, arguing from known data, that the maximum temperature at the bottom of a crust of about forty-five miles in thickness, must be in the neighborhood of 1,530° C., although some amount of uncertainty is necessarily induced by our want of knowledge of the conductivity of rock at high temperatures. Anyhow, it is probable that at the depth indicated the temperature does not exceed the melting-point of platinum. Such a crust would contain about one thirtieth of the earth's volume, and if throughout it the radium heat energy were of the average of that exhibited by many samples examined by Strutt, the temperature of the earth could be maintained until our stores of uranium suffered sensible depletion. Such an assumption would lead to the conclusion that the whole of the central portion of the earth consists of non-radioactive substances at an approximate uniform temperature somewhat below the melting-point of platinum. A brief summary of the evidence previously at our disposal may not be out of place.

In the first edition (1867) of Thomas and Tait's 'Natural Philosophy' we find the tidal evidence summarized as follows:

> It seems certain, therefore, that the tidal effective rigidity of the earth must be greater than that of glass.

In the 1883 edition of the same work a discussion of the question by Professor George Darwin is given. He states:

> On the whole we may fairly conclude, whilst there is some evidence of a tidal yielding of the earth's mass, that yielding is certainly small, and that the effective rigidity is at least as great as steel.

In a later paper (*Proc. Roy. Soc.*, 1885) Darwin pointed out that this conclusion was based on the assumption that oceanic tides would have their equilibrium value, and that the validity of this assumption was open to doubt. Nevertheless, the evidence clearly indicated a high degree of effective rigidity.

Hough (*Phil. Trans.*, A, 1895, 1896) discussed the variation of latitude, and, after correcting a small mistake of Newcomb's (who was the first to suggest the explanation), found the prolongation of the Eulerian nutation from 305 to 430 days as indicating an effective rigidity of the earth about equal to that of steel. Wiechert (*Trans. Roy. Soc. Göttingen*, 1897), of Göttingen, found that the mean density, ellipticity and precessional constant were consistent with the hypothesis of homogeneous core with lighter surface layer.

Mr. R. D. Oldham (*Phil. Trans.*, 1900), in a paper on the 'Propagation of Earthquake Waves,' came to the conclusion that the evidence pointed to a central metallic core, and to the existence of marked differences in the physical constants of the core and the surrounding crust. He, however, assigned a comparatively small radius to this core, viz., about 0.55 that of the earth.

I will now call your attention to the light thrown on this subject by the recent investigations of Professor Milne. The difference in the rate of propagation of earthquake waves through the earth's interior

and through the crust has led him to the conclusion that the material below a depth approximating to thirty miles is of a uniform nature, and that the change in physical constitution is abrupt at some such depth as that indicated. He writes as follows:

> For chords which lie within a depth of thirty miles the recorded speeds do not exceed those which we should expect for waves of compression in rocky material. This, therefore, is a maximum depth at which we should look for materials having similar physical properties to those we see on the earth's surface; beneath this limit the materials of the outer part of this planet appear rapidly to merge into a fairly homogeneous nucleus with a high rigidity.

In the *Transactions of the Royal Society* for 1905 will be found a paper by Lieut.-Colonel S. G. Burrard on 'The Intensity of the Force of Gravity in India.' Colonel Burrard writes as follows:

> Geodetical observations have shown that the density of the earth's crust is variable, but they have not given any positive indications of the depths to which these observed variations extend. All calculations of the depths of subterranean variations in density and of the mountain compensation have, therefore, to be based on arbitrary assumptions of depth. The fact that the plumb-line seems generally to respond readily to the results given by the pendulum perhaps justifies the inference that the observed variations in the density of the earth's crust are not deep-seated. If an abnormal amount of matter exists in the crust near the surface, it will exercise direct effects upon plumb-lines and pendulums in the vicinity, but if it lies at a great depth its effects, especially on plumb-lines, will be less perceptible. * * * I have taken several instances of abnormal pendulum results from table, and have found in each case direct response from the plumb-lines at neighboring stations. This conformity could hardly ensue if the variations in density extended to greater depths than thirty or forty miles. Our results do not justify us in asserting that no deep-seated variations in density exist, but they do justify the belief that the variations in density which have been discovered are apparently superficial.

It is interesting to notice the agreement between results drawn from such dissimilar sources. On the one hand we have had to deal with effects produced by almost inconceivably small particles traveling with immense velocity; on the other, with effects dependent upon the behavior of 'the huge terrestrial globe.' That travelers starting from such opposite extremes should arrive at a common destination is in itself a striking example of the scope and accuracy of the work undertaken by investigators in physical science.

It is possible that the evidence from each source, considered independently, might be regarded as inadequate, but the cumulative effect is sufficiently strong to justify the belief that some marked physical change in the constitution occurs at a depth of some thirty to fifty miles.

At all events, we have indications that, with the exception of a comparatively thin crust, the earth consists of a non-radioactive substance with a rigidity approaching that of steel, with an average temperature in the neighborhood of 1,500° C., and a density at that temperature of about 5.6° C.

An interesting question awaiting solution is the probable constitution of this core.

The above is but an example of the many fascinating problems upon which fresh light has been thrown by the revelations of recent discoveries in radioactivity, and the temptation to dwell on such themes is correspondingly great: but I feel that such a task should be committed to hands more capable than mine.

Fortunately, in the discussions which will take place during our meeting ample opportunity will be afforded those entitled to speak with authority. Nevertheless, there are one or two further aspects of the matter which I will venture to touch upon, although but an onlooker. I would, first of all, urge the importance of a study of

what may be termed the natural history of the elements. We require more information as to their comparative proportions in different localities. The fact that, given the amount of uranium in a sample of native rock, we can predict with certainty the amount of radium contained in the same specimen is of startling significance.

The natural law which governs the proportions of these two substances may have a far wider-reaching scope than we at present suspect. Nature appears to present to us a grouping which would not naturally have occurred to the mind of the chemist; lead and silver, copper and gold, and, again, platinum and iridium seem invariably to be introduced to us by nature as if bearing to each other some kind of blood relationship.

The facts we already possess seem dimly to indicate some close relation between elements which we have hitherto considered as outside the bounds of consanguinity, and for a fuller knowledge of this important branch of natural history we require the assistance of the practical engineer, the geologist, the metallurgist and the chemist.

Many of the results arrived at by the investigators into the phenomena of radioactivity can apparently only be verified by the lapse of considerable intervals of time. It is, probable, for example, that we can estimate with some degree of accuracy the time required for the dissolution of half a given mass of uranium or radium, but the complete verification of our inferences must probably be left to a future generation. If we accept this view, it is our duty to provide our successors with data on which their conclusions may be based. If, for example, carefully determined masses of the more radioactive substances could be placed in such circumstances as to remain untouched until the meeting of this association some hundred years hence, our successors, who would doubtless be equipped with apparatus of research more accurate and more sensitive than any in our possession, would at all events be placed in a position to establish by direct methods the accuracy of inferences based upon the experimental data now at our disposal. This task is one which, it appears to me, might well be undertaken by Section A, and I trust that this suggestion may be held worthy of some consideration.

It appears probable that one gram of radium diminishes in weight by about half a milligram per annum; hence, if the funds of this society admitted of the imprisonment of some definite mass of radium, our successors a hundred years hence would, even if they possessed only the apparatus now at our disposal, be able to determine its loss with sufficient accuracy to enable them to verify the truth of the conclusions arrived at by the physicist of to-day, while the investigation of the radioactivity of the residue would possibly throw light on many problems now awaiting solution.

It would appear that if we made a similar imprisonment of uranium, a like degree of accuracy would not be attainable until after the lapse of half a million years, and I am afraid that our interest in the work of our successors can not be expected to cover so long a period. Nevertheless, it is probable that the presence of the products of decomposition could easily be detected after the lapse of a comparatively short interval of time.

The experiment might well be extended so as to include examples of all the elements capable of such treatment; and with each prisoner should be placed a full record of its physical constants, such as mass, density, electrical conductivity, specific heat, etc., with a clear indication of what is believed to be the probable accuracy of such determination.

During the past twenty-five years much thought has been devoted to the accurate determination of certain physical constants. This is very apparent in the case of one of the most important—namely, that commonly termed the 'mechanical equivalent of heat,' or, as I prefer to define it, the 'thermal equivalent of energy.' When Lord Kelvin addressed you in 1881, I think it probable that he would have indicated the value obtained by Joule—viz., 772.6 foot-pounds—at Manchester, as the quantity of work required to raise the temperature of one pound of water through 1° F. at 62° F. It is true that the results of Rowland's classical investigation were published in 1880 and 1881, but the discrepancy between his conclusions and those of Regnault regarding the change in the specific heat of water at temperatures between 0° C. and 30° C. introduced an element of uncertainty.

As a consequence of this discrepancy much experimental work on the subject has been performed in the last quarter of a century, and I think it may be said without hesitation that the value of this important constant is now ascertained with an accuracy of about one part in 2,000. The amount of labor which has been employed in the determination of this thermal constant is extraordinary, and, as I have pointed out elsewhere, it well illustrates the cosmopolitan character of scientific investigation.

I have given reasons (Griffiths, 'The Thermal Measurement of Energy') for specially selecting for consideration the determinations of Rowland, of Bartoli and Stracciati, of Ludin, of Callendar and Barnes, of Schuster and Gannon, and I have ventured to add my own. Thus Baltimore, Pisa, Zurich, Montreal, Manchester and Cambridge have all contributed to the solution of the problem, and we may now with some certainty say that 777.7 foot-pounds at Greenwich are very closely the equivalent of the amount of heat required to raise one pound of water through 1° on the hydrogen scale at 63.5° F.

It may possibly appear that the result just quoted is a somewhat poor return for the expenditure of so much thought and labor. I would call attention, therefore, to the fact that the value of this equivalent is dependent on the measurements of many other natural constants; hence any agreement between the results obtained by the observations of Rowland and some of the other observers I have mentioned would only be possible in the absence of errors of appreciable magnitude in the determinations of mass, of change of temperature, and of electrical resistance and current. Certain discrepancies have led to the discovery of a hitherto unsuspected cause of inaccuracy, especially in the determination of temperature, and thus the inquiry has rendered valuable service in many branches of physical inquiry.

For example, so far back as 1893 I ventured upon a prophecy that the value assigned to the E.M.F. of a Clarke's cell was somewhat too high, and that it was possible that 1.4328 represents more truly the potential difference of a Clarke's cell at 15° C. than the ordinarily accepted value of 1.4342. In the report of the Electrical Standards Committee for 1897 will be found a discussion of this matter, and one of the consequences of the deliberations of that committee is to be seen in the ampere balance now standing in the National Physical Laboratory.

The results of the observations obtained by this instrument will, I believe, shortly be published by Professor Ayrton and Mr. Mather, but I am at liberty to state that, so far as the observations have been reduced, they point to the conclusion that

the prophecy to which I have referred is closely fulfilled. We may say, therefore, with some confidence that the values of those units which form the basis of our system of electrical measurement are not only practically determined with a high degree of accuracy, but that also our measurements of temperature and of energy are placed on a satisfactory footing.

The last few years have been fruitful in revelations which not only profoundly affect the views of students of science, but also are of such a nature as to catch the eye of the public. In some cases the applications of these discoveries to the purposes of mankind have been evident and immediate. Every well-equipped hospital possesses apparatus for the production of Röntgen rays, and I suppose that every bluejacket in the navy has some degree of acquaintance with those applications of science which have resulted from the discovery of Hertzian waves.

The ambition of the student is naturally fired by such examples, and there is a possible danger that the plodding but absolutely necessary work of accurate measurement may suffer by neglect. I, therefore, venture to repeat the well-established axiom that our advance in scientific knowledge is a function of accurate measurement, and that the student who devotes his energy to the determination of some physical constant is probably giving a 'point of departure' to the pioneer. For it must ever be remembered that to the scientific investigator the rule of three has ceased to hold any significance.

When Lord Rayleigh discovered that the mean weight per liter under standard conditions of chemical nitrogen was 1.251, and that of atmospheric nitrogen was 1.257, the believer in the rule of three would have been unlikely to suspect that this difference of 0.006 would supply the clue which led Lord Rayleigh and Sir W. Ramsay to the discovery of a new element, a discovery which in its turn led to others of possibly even greater importance. For all we know the next decimal place in any hitherto accepted value may afford another example of the truth of the statement that a part may be greater than the whole.

At the time when Lord Kelvin delivered the address to which I have already referred, the truth of the second law of thermodynamics was probably not so generally accepted as is the case at the present time. Each apparent example of violation of that law has on closer examination proved to be additional evidence of its validity. We seem unable to find those 'sorting demons' of Maxwell's, the existence of which appears necessary for its violation.

Mr. Campbell recently expressed doubts as to the application of thermodynamic considerations to osmotics. He contended that the errors in the determination of osmotic pressure were greater than those which could be attributed to experimental sources. Now, the theoretical relation between osmotic pressure and the freezing-point is based directly on thermodynamic considerations, and it was because I entertained a belief that the most direct evidence of this much-debated matter could be obtained from the observation of the freezing-point of a very dilute solution that I embarked on a series of somewhat elaborate experiments during the years 1897 to 1901. My removal from Cambridge and the death of my assistant, Mr. C. Green, compelled me to leave that inquiry in an unfinished condition. Nevertheless, I had investigated the depression of the freezing-point in certain solutions varying in strength from 0.0003 to 0.025 gm.-molecule per liter.

Subsequently to my departure from

Cambridge Mr. Bedford reerected the apparatus in another building. After having surmounted great difficulties, he repeated many of my experiments, and he informs me that the numbers he has so far obtained are in almost entire agreement with those previously obtained by me. The molecular depression in the case of cane sugar I found to be 1.858, of potassium chloride 3.720, and I understand that Mr. Bedford's experiments agree with these results with a discrepancy of less than 1 part in 1,000. The most probable number obtained from theoretical considerations would be in the former case 1.857, in the latter 3.714. As Mr. Whetham has pointed out, unless there is some balancing of opposite errors of a very improbable nature, it is difficult to imagine a more direct vindication of the application of thermodynamic considerations to the phenomena of solution. I may add that I also examined correspondingly dilute solutions of sodium chloride, barium chloride, sulphuric acid, potassium bichromate, magnesium chloride and potassium iodide; but, owing to the circumstances to which I have referred, I was unable to repeat these experiments in such a manner as to enable me to attach great importance to the resulting figures. Nevertheless, I obtained values which strengthened the conclusions to which I was led by the more exhaustive examination of the dilute solutions of sugar and potassium chloride.

So far back as the Liverpool meeting of this association I expressed a hope that the experimental difficulties of the direct measurement of osmotic pressures would be overcome, as such direct measurement would afford the most useful data by means of which to obtain further light on the much-vexed question of the nature of solutions. I remember, also, that it was the general opinion of those who had given attention to this matter that the experimental difficulties were insuperable.

I am glad, therefore, to have this opportunity of stating my high appreciation of the manner in which Lord Berkeley and Mr. Hartley have grappled with the difficulties of this investigation. They have proved that the osmotic pressure obtained by direct measurement agrees with that derived from vapor-pressure observations to within less than 5 per cent.[1] The agreement is of great importance, as it diminishes our doubts as to the extent to which the imperfections of semi-permeable membranes may affect the validity of results dependent upon their behavior, and points to the possibility of determining the osmotic pressures of concentrated solutions by measurement of their vapor pressures.

I trust it will not be thought out of place if I here refer to the interesting correspondence which has recently appeared in *Nature* on the thermodynamic theory of osmotic pressure, and the allied, but by no means identical, problem of the difference between electrolytic and non-electrolytic solutions.

On the one side we have Professor Armstrong, whose chief desire appears to be the vindication of the moral character of what he terms 'the poor molecule'; and Mr. Campbell, whose doubts concerning the second law of thermodynamics are closely connected with a lurking belief in the existence of Maxwell's 'sorting demons'; and by way of reserves we have Professor Kahlenberg, who contends that 'thermodynamic reasoning can not be applied to actual osmotic processes' on account of the

[1] Concentration.	Direct O. P. at 0° C.	O. P. deduced from Vapor Pressure at 0° C.
540 grains per lit. solution..	67.5	69.4
660 grains per lit. solution..	100.8	101.9
750 grains per lit. solution..	133.7	136.0

Proc. Roy. Soc., June, 1906.

'selective action of the membrane' and 'insists that the formation of crystals from a solution or the concentration of a solution by evaporation are not osmotic processes.'

On the other hand we have Mr. Whetham, who, I confess, seems to me to be capable of holding his own without need of reinforcements. He has pointed out that confusion has arisen from the use of the term 'osmotic pressure' to denote the actual pressure experimentally realized in certain conditions, as well as the ideal pressure required in thermodynamic theory. With regard to the theory of electrolytic dissociation, Mr. Whetham shows that the fact that the velocities of the ions are constant in dilute solutions and decrease slowly with increasing concentration, while the conductivity of a dilute solution is at most proportional to the first power of the concentration, appears irreconcilable with any assumption as to the existence of the active part of an electrolyte in the form of combined molecules when in solution. I would here join with Mr. Whetham in the request that those who oppose the theory of ionic dissociation would state their views as to the mechanism of electrolysis, and their reasons for supposing that the application of the principles of thermodynamics to the phenomena of solution is unjustifiable.

Professor Armstrong remarks that it is unfair to 'cloak the inquiry by restricting it to thermodynamic reasoning, a favorite maneuver with the mathematically minded.' He adds that such a course may satisfy the physicist, but 'is repulsive to the chemist.'

The inquiry, 'Why is the application of thermodynamic reasoning repulsive to the chemist?' naturally suggests itself. I confess that at one time I regarded the extreme advocates of the theory of ionic dissociation with a certain amount of suspicion, but I think that most of those who have studied the evidence now at our disposal, or who have been engaged in experimental investigation into this interesting branch of physics, can not fail to agree with Mr. Whetham that, as regards the fundamental conceptions of the theory, 'the cumulative evidence seems overpowering.' At all events, we may consider that the application to the phenomena of solution of reasoning based on thermodynamic considerations is justifiable, until we are presented with stronger arguments than those based on the repulsiveness to certain chemists of the conclusions to which it leads, or the doubt it throws upon the activities of Maxwell's demons and the selective action of semi-permeable membranes.

I will now trespass upon your forbearance and pass from the consideration of such special departments of natural science as usually engage the attention of members of this section to some more general considerations, which naturally arise in any comparison of our knowledge of to-day with that which we possessed when we last met in this city.

It will, I think, generally be admitted that during the last twenty-five years the increase in our 'natural knowledge' has been greater than in any previous quarter of a century.

Day by day we are adding new facts to our storehouse of information, until it has now become impossible for the individual to have more than a superficial knowledge of the contents of the building. And although this accumulation is one which we may well regard with satisfaction, it necessarily gives rise to difficulties unfelt by our predecessors.

I venture to indicate one of such difficulties, one which has been brought home to me both by my experience as an examiner and by the fact that during the past few years I have had to preside over many

meetings of examiners, and to mark the effect of examinations on the teaching in our universities.

We now expect a student to acquire in a three years' course a far greater amount of information than was considered necessary, say, twenty-five years ago. The attention both of the teacher and of the taught is naturally directed to those extremities of the branches of science in which the growth has been most marked in recent years, and I venture to think that there is in consequence some danger of our neglecting the roots of the whole matter. Compare, for example, a final paper in chemistry in any one of our universities with its predecessor of a quarter of a century ago.

The enormous advance of organic chemistry has necessarily reacted on the examinations, and thus the student is unable to devote an adequate proportion of his time and attention to the foundations of the subject. The same remark applies in the domain of physics. There is a danger, therefore, of our educational edifice becoming top-heavy.

I have heard complaints, on the one hand, from the examiners that while the candidates frequently exhibit considerable knowledge of the most recent scientific developments, they show a lamentable ignorance of the simple phenomena and the principles they illustrate. On the other hand, I have heard from candidates that many of the questions were too simple—that they were concerned with principles and facts to which their attention had not been directed since they first began the study of natural science.

My own experience has been that the simplest questions are those answered in the least effective manner. A candidate unable to give satisfactory illustrations of Newton's laws will discourse upon the mass of an electron or the nature of the Röntgen rays, and attempt the solution of problems on such subjects as Hertzian waves and electric convection.

I hope that the attention of both examiners and teachers may be directed to the best methods of dealing with what appears to me to be not only a serious but an increasing evil.

To pass from one of the inconveniences which inevitably arise from growth, it is pleasant to dwell upon its more gratifying consequences.

Perhaps one of the most marked characteristics of the progress of science in recent times is the increasing public appreciation of the importance of original investigation and research.

The expansion of the university colleges in number and importance has greatly assisted and quickened this movement.

Twenty-five years ago there were comparatively few laboratories which held out any possibility of research to the English student. True, there were giants in those days, men, as a rule, working under difficulties greater than those encountered by their successors of to-day. The better equipment of our laboratories and the growth in the number and activity of our scientific societies have played no small part in stimulating public interest. Nevertheless, much remains to be done. Those who have read Professor Perry's somewhat pessimistic words on England's neglect of science must admit that, however rapid our progress, the British people have not yet so fully awakened to the national importance of this question as some of our competitors.

The idea that a degree is one of the chief objects of education yet lingers amongst us. The conviction that it is a national duty to seek out and, when found, utilize the latent scientific ability of the rising generation for the purpose of adding to our stores of

natural knowledge still needs to be brought home to the 'man in the street.' And here I would venture to indicate my personal belief in the necessity of more free communication between the laboratory and the market-place. It is possible that the language of science is becoming too technical, and that the difficulties with which scientific inquirers have been faced in past times have tended to habits of exclusiveness. For example, complaints are frequent that our manufacturers are less alert in grasping the practical applications of scientific discovery than their competitors in Germany and the United States. I confess, however, that it seems to me possible that the fault is not altogether on the side of the manufacturers. We want missionaries to preach the doctrine that one of the greatest of national assets is scientific discovery. If we can convince the men of business of this country that there are few more profitable investments than the encouragement of research, our difficulties in this matter will be at an end.

It is my lot to serve on the education committees of three county councils, and I have been much struck by the readiness of the members of those bodies to extend such encouragement whenever it has been possible to convince them that the results may conduce to the prosperity, the comfort and the safety of the community.

It has also been my privilege to address meetings of the men who work in the coalfields of South Wales. I have attempted to direct their attention to the advantages which they have derived from the labors of those who have endeavored to probe the secrets of nature in the laboratory; I have tried to show how discoveries based on the researches of Humphry Davy, Faraday, Joule, for example, have not only diminished the dangers to which miners are exposed, but have also, by increasing the demands upon our stores of energy, given employment to thousands of their fellow-workers.

My experiences lead me to the belief that these men are ready to support the action of their representatives in extending support and encouragement to all efforts to assist the advance of scientific discovery.

It is possible that in dwelling on this matter I am trespassing on your forbearance, but I can not resist this opportunity of pleading for the extension of your sympathies beyond the walls of the laboratory. The old toast, 'Here's to science pure and undefiled; may it never do a ha'porth of good to anybody,' may possibly be an excellent one in the laboratory; for, so far as I know, no great scientific principle has ever been established by labors prompted solely by desire for financial gain. Nevertheless, if we wish for the support of our fellow-countrymen, that toast is not one for public dinners. There is no scientific society which is brought into such close contact with the public as is the British Association, and affiliated with that association are some scores of local scientific societies, containing many thousands of enthusiastic observers and inquirers. If this great organization were seriously to take up the task of bringing home to the minds of the people of this kingdom the enormous value of the results of scientific inquiry, I believe it might be possible to change the indifference and apathy of our public bodies into active interest and encouragement. If each affiliated society would institute a series of public non-technical lectures, of such a nature as to bring home to the minds of the hearers some comprehension of the results of the work of Faraday, of Wheatstone, of Pasteur, of Maxwell, of Lister and of Kelvin, the change in the public attitude would be real, evident and fruitful.

In conclusion, one is tempted to seek for

the underlying cause of the acceleration in the rate of advance of natural knowledge. Is it to be found in the increase in power of the human intellect, or the diversion into one particular channel of activities previously otherwise employed? It is possible that the human intellect has, by the processes of evolution, become more powerful, and that man's ability to decipher the secrets of nature has thereby increased. I think, however, that it would require a bold advocate to support this thesis. If any such mental evolution has taken place, it is strange that it should be restricted to one particular sphere of activity. Are our poets and authors of to-day greater than Homer, our statesmen than Pericles? Or, passing into the domain of science, can we say with confidence that, in pure power of reasoning, Maxwell was undoubtedly the superior of Archimedes?

I have elsewhere indicated what appears to me to explain the mystery of this acceleration, namely, *the extension of our senses* by mechanical appliances. When we supplement our eyes by the bolometer and the electric coherer, the range of our vision is augmented a thousandfold. By the use of the electroscope and the galvanometer we have extended our senses of sight and touch until we can detect the presence of an electron.

Having realized the imperfection of our faculties, we have called upon nature in all departments of science to supply our deficiencies, and are thus enabled to walk with confidence where previously all seemed dark.

From the time of Archimedes to that of Bacon we despised natural knowledge while we deified intellect and authority; hence for nearly 2,000 years our record was one of retreat rather than advance. When the philosopher left his study and applied his powers of observation to the phenomena of the universe, progress became a reality, and thenceforward the march of discovery has known no backward step. We have, therefore, every reason to believe that when the association again visits this ancient city our president will be able to chronicle an increase in natural knowledge even greater than that which has been one of the distinguishing characteristics of the last quarter of a century.

E. H. GRIFFITHS.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SPECIAL MEETING, ITHACA, NEW YORK, JUNE 28–JULY 3, 1906.

SECTION E—GEOLOGY AND GEOGRAPHY.

THE section organized at 11 A.M., Friday, June 29, directly after the adjournment of the first general session of the association, in the geological lecture room, McGraw Hall, with Vice-president and Chairman A. C. Lane in the chair and thirteen members and seven visitors present. Before proceeding with the program of papers the following preamble and resolution were offered by Mr. George H. Chadwick, of Albany, New York:

WHEREAS in the decease of Professor Israel C. Russell Section E has lost an efficient officer and one of its foremost workers and best loved members.

Resolved, That the section express its deep sorrow and its sense of the great loss to geologic science through the event.

Remarks to the motion were made by Messrs. A. C. Lane, H. S. Williams, D. S. Martin and E. O. Hovey.

The following papers were then read in accordance with the printed program:

Revision of the Geological Section passing through Ithaca, N. Y.: Professor H. S. WILLIAMS, Cornell University. (By permission of the Director of the U. S. Geological Survey).

The author explained that the revision

of classification and nomenclature proposed was the result of a resurvey of the formations examined in preparation of the map and folio of the Watkins and Catatonk Quadrangles now in preparation. The section is the standard section of the New York Devonian as originally defined and described by Vanuxem and Hall in 1842–1843. The revision of the classification and nomenclature is based upon a critical study of the composition, sequence and range of the fossil faunas of the Watkins and Catatonk Quadrangles. The thicknesses are estimated as for a generalized section passing through the rocks at Ithaca, N. Y.

The taxonomic classification into series, formations, members and lentils, is in accordance with the rules of the U. S. Geological Survey published in the 24th Annual Report for 1902–1903.

The following chart expresses in brief the classifications and nomenclature presented, the new names having been accepted by the committee on geologic names of the U. S. Geological Survey.

The principal changes affecting nomenclature are the following: viz., the *Nunda shale and flagstone formation* is the stratigraphic equivalent of Hall's Portage or Nunda group, the standard section of which is found in the Genesee Valley. The term Portage was used by Hall for the sandstone member at the top of his Portage or Nunda Group as well as in the name of the other group. Of the two synonyms the first (Portage) is left to be applied in its specific sense to the Portage sandstone member, and Nunda is retained for the formation name.

The lithologically discriminated members of the Nunda characteristic of the Genesee Valley section (*i. e.*, Cachaqua, Gardeau and Portage) are not distinguishable in the Ithaca section. The subdivisions in the latter section are the *Sherburne flagstone*, the *Ithaca shale* and the *Enfield shale members*. The first of these is the equivalent of the Sherburne flagstone of Vanuxem; the second is the typical Ithaca group of Hall and later writers; the third is the

SCHEME OF CLASSIFICATION AND NOMENCLATURE OF THE GEOLOGICAL SECTION PASSING THROUGH ITHACA, N. Y.

	Formations.	Members and Lentils.	Section.	Thickness.
Erie (division or) series of Vanuxem.	*Chemung.* Shale and sandstone formation.	*Fall Creek* conglomerate lentil.		0–10 ft.
		Wellsburg sandstone member.		600–650 ft.
		Cayuta shale member.		600 "
	Nunda. Shale and flagstone formation.	*Enfield* shale member.		550–800 ft.
		Ithaca shale member.		80–300 "
		Sherburne flagstone member.		188–260 "
	Genesee. Shale formation.			125 ft.
	Tully. Limestone formation.			10–30 ft.
	Hamilton. Shale formation.			1,035 ft.
	Marcellus. Shale formation.			125 ft.
	Onondaga. Limestone formation.			125 ft.
	Oriskany. Sandstone formation.			0–4 ft.

'upper part of the Portage' of the classification proposed by Williams in 1884; and the name *Enfield* is applied for the name of the town of Enfield where the member is typically exposed.

The boundary between the Nunda and Chemung formations is established on the basis of change in the generic composition of the faunas occurring at the horizon indicated. The two genera *Dalmanella* and *Douvillina,* and the species *Spirifer disjunctus* are among the more characteristic of the forms marking this change. The *Cayuta shale member* contains the typical Chemung fauna of the Chemung Narrows section; it is paleontologically limited by the Nunda fauna below, and by the fourth of the known zones of *Tropidoleptus* appearing above the Hamilton formation, to which the name *Swartwood Tropidoleptus zone* has been applied by the author for the outcrop southwest of Swartwood at an altitude of about 1,600 feet A. T., containing the fauna.

The name *Cayuta* is applied for the Cayuta Creek, along the sides of which from Cayuta Lake to its discharge into the Susquehanna River typical exposures of the Cayuta member may be seen.

The second member of the Chemung is named *Wellsburg sandstone member* for its outcrop at Wellsburg and above in the hills of Ashland. It is paleontologically discriminated by absence of many common Chemung species and lithologically by the more sandy nature of the rocks; and the thin-bedded slabs characteristic of the higher 'Catskill' rocks are conspicuous in the upper portion.

The Wellsburg member is terminated above by the *Fall Creek conglomerate lentil,* a thin band of conglomerate discovered in place at the top of the Ashland Hills and frequently visible in detached pieces on tops of other hills along the southern townships of the state.

The Fall Creek conglomerate lentil is interpreted to be the equivalent of the conglomerate of that name in Bradford and Tioga Counties, Pennsylvania. In the beds immediately under the conglomerate, and terminating the Wellsburg member, occur in great abundance the shells of *Leptostrophia nervosa* and *Orthothetes chemungensis.* To distinguish this particular horizon the name *Ashland Leptostrophia zone* has been applied to the zone by the author. The author stated that other evidence obtained by comparison of this section with others indicates that the highest stratigraphic extension of the Chemung fauna is not reached at the top of the Wellsburg member, but that to the west and south of this section rocks stratigraphically still higher may bear many of the species of the Chemung formations.

Professor Williams's paper was discussed by Messrs. J. C. Branner, C. A. Hartnagel and D. S. Martin.

Abyssal Igneous Injection as a Causal Condition and as an Effect of Mountain Building: Dr. R. A. DALY, International Boundary Commission, Ottawa, Canada. (Illustrated with a diagram.)

The contraction theory of mountain-building is hypothetically extended to cover the explanation of igneous intrusion, geosynclinal down-warps, the location of mountain-ranges, and the common association of intense mountain-building with the batholithic intrusion of magma. Among the chief postulates are: (1) an earth-crust about twenty-five miles thick, overlying a substratum which, on account of its high temperature, acts as a viscous liquid; (2) the division of the crust into a shell of compression about five miles thick, overlying a shell characterized by cooling tension. The shell of tension extends from

the bottom of the shell of compression down to the substratum.

One effect of cooling tension is to produce cracks in the lower shell; these are only partly closed by the shearing of masses against masses. Because of the solid continuity between the two shells, some of the tension remains unrelieved.

Tension in the lower shell permits of the abyssal (dike) injection of the substratum fluid into the crust. This injection is especially facilitated in earth-zones established by cosmical stresses. The hydrostatic and expansional pressures normal to the walls of such an abyssal dike cause lateral creep and special condensation of matter in the shell of tension. This movement induces a down-warp of the earth's surface overlying the zone of injection. When the down-warp is of large size it is a geosynclinal. Its sedimentary filling is accomplished through the shearing of the shell of compression over the shell of tension. This breaking of the solid continuity between the two shells releases all the accumulated tension. As a result, extraordinarily large bodies of magma are injected from the substratum into the shell of tension beneath the mountain-range. The assimilation of the folded rocks of the range leads to the formation of granitic batholiths.

Dr. Daly's paper was discussed by Messrs. A. C. Lane, J. C. Branner and D. S. Martin.

Brewsters Neck, Connecticut: Dr. F. P. Gulliver, Norwich Town, Conn. (Abstract read by E. O. Hovey.)

Brewsters Neck, Conn., is a deposit of water-laid sand and gravel lying between the preglacial valley of the Thames River, and the preglacial tributary which may be called the Poquetanock River.

The surface of this deposit rises from 70 to 85 feet above the level of the tide water as it exists to-day. It lies from 100 to 150 feet above the level of the bed of the preglacial Thames River.

On the east and west sides of this deposit there is a steep slope. On the north side the surface of the deposit comes directly against the bed rock, which at this point is covered with a thin deposit of till not completely masking the ledges which appear at various places.

On the northwest corner of this deposit there are distinct lobes projecting toward the northwest and between these lobes and the bed-rock slope to the north, which is very steep at this point, there is a deep hollow which is popularly called a 'valley.' The form of this 'valley' shows conclusively that it was not formed by degradation, but by aggradation.

On the southeast corner of this deposit the surface merges gradually into the gentle slope of a low hill, which is bed-rock covered with till. West of this hill is a confused mass of kames and kettle-holes which are beneath sea-level, and since these are now filled with water they are used for floating lumber for the Dawley Lumber Yard at Fort Point.

Perhaps the most interesting point along the margins of these deposits lies just above these two salt-water ponds, which fill these kettle-holes. The surface of this deposit, which the author would name a *delta-terrace,* slopes from the northeast, where the highest point is 85 feet above the level of the sea, toward the southwest, where the surface is about 70 feet. The deposit is undoubtedly a glacial delta. Its distinct lobes and structure are typically that found in deposits laid by a stream emptying into standing water. It is very similar to the structure reported by the author of this paper as occurring at the Navy Yard, above New London.[1]

[1] 'Thames River Terraces in Connecticut,' *Bull. Geol. Soc. Am.*, Vol. 10, 1898, pp. 492–494.

A new point in regard to the theory of the formation of water-laid glacial deposits is believed to be as follows: When the margin of the ice-sheet was retreating by the annual summer melting faster than ice was supplied, the ice remained longest in the valleys. Masses of ice would thus be left in the deeper valleys which would rise many feet above the surrounding hills. Between these ice masses standing water would occur either as arms of the ocean or as ice-dammed glacial lakes between these ice-blocks. In these bodies of standing water the streams from the melting ice would deposit their sand and gravel, and at the point where the streams issued from the ice there would be eskers and ice-contact slopes. These latter deposits would contain the larger materials, and the fine sand would be found farthest from the point where the streams issued from the ice. Where the supply of rock waste was sufficient to fill up the space lying between these ice-blocks, a flat topped delta-terrace would be formed; where the supply was not sufficient to fill up the water body, lobes would occur. These lobes would project into the water body, and from the axis of the arched layers as shown in sections, the direction of flow taken by a given glacial distributary may be discovered.

In this deposit, therefore, the lobes at the northwest corner show that the sand of which they are built was coming from the southeast. The arched layers shown in the sections at the southwest corner of this deposit indicate that the material there found came from the northeast. Other sections of this delta-terrace at Brewsters Neck, as revealed by the excavations made for the State Hospital, show that in the center of the deposit there were alternating currents coming from both the east and the west.

The author believes from the facts shown by these recent cuttings and from the facts which have long been recognized from the surface form, that this deposit was built by streams issuing from two blocks of ice, one of these blocks occupying the valley of the glacial Thames, the other occupying the valley of the tributary of the Thames River which flowed through the Poquetanock Valley. The slope of the surface of this delta-terrace indicates that the last source of the material was from the Poquetanock ice-block on the east.

Notes on the Geology of the Guaynopita, Chihuahua, Mexico, Mining District: Dr. E. O. HOVEY, American Museum of Natural History, New York. (Illustrated with lantern slides.)

The Guaynopita district lies in the heart of the Western Sierra Madre in northern Mexico. It shows a series of Cretaceous limestone and schist and gneiss overlain by volcanic rocks (andesites) and invaded by granite intrusions. Later volcanics (basalt, andesites and rhyolites) have supervened, basins have been filled with sandstones and conglomerates, and the whole region has been deeply dissected by the Aros and its tributaries.

Dr. Hovey's paper was discussed by Messrs. A. C. Lane and C. R. Dryer.

The Relations of the Drainage of the Santa Clara Valley, California, to that of the Pajaro River: Professor J. C. BRANNER, Stanford University.

Several years ago Dr. Joseph Le Conte advanced the theory that the drainage of the Sacramento Valley of California formerly entered the Pacific Ocean through the Bay of Monterey instead of through the Golden Gate as it does at present. This theory was based chiefly upon the absence of a submerged channel outside of the Golden Gate and the presence of such a channel in the Bay of Monterey. Later

the study of the fish faunas of the streams of California by Professor C. H. Gilbert and his colleagues showed that there had formerly been some connection between the Sacramento, the Coyote, the Pajaro, the Salinas and various other streams that are now separate. These faunal relations seemed to give strong support to the theory of the newness of the Golden Gate channel.

Later study shows that the mingling of these faunas may be explained otherwise. During the glacial epoch the region in question stood from 2,000 to 3,000 feet higher than it does at present. The Bay of San Francisco did not then exist, but the Sacramento and Coyote drainage flowed through it. Coyote Creek rising on the western slope of the Mt. Hamilton range flowed into the Santa Clara Valley at the top of the watershed between the present Coyote Creek and the Pajaro drainage. An alluvial cone was built up on the flat valley-floor where the Coyote emerged on the plain of the Santa Clara Valley. As this cone grew the Coyote swung from side to side, emptying its waters now into the Bay of San Francisco and now into the Bay of Monterey. Fishes ascending from the Sacramento into the Mt. Hamilton range, could later descend into the Pajaro drainage. The elevation of the coast at that period carried the mouth of the Pajaro farther toward the west, so that fishes could pass from the Pajaro into the San Lorenzo and into the Salinas without entering the sea.

The depression following the glacial epoch submerged the mouth of the Sacramento forming the Bay of San Francisco, and separated the San Lorenzo from the Pajaro and the Salinas Rivers. The decreased precipitation diminished the volume of Coyote Creek and it ceased to build the cone near Madrone Station, and since then it has flowed toward the Bay of San Francisco and has been cutting into its alluvial cone.

Professor Branner's paper was discussed by Messrs. T. C. Hopkins, C. R. Dryer, A. C. Lane, George H. Chadwick and E. O. Hovey.

The Geology of Coon Butte, Arizona: Messrs. D. M. Barringer and B. C. Tilghman, Coon Butte, Arizona. (Illustrated with diagrams and specimens and presented by J. C. Branner.)

Coon Butte, Ariz., is a low crater-like hill six miles south of Sunshine Station on the Santa Fe Railway, and about twenty-five miles southeast of Flagstaff. The general geology of the surrounding country is very simple, consisting of horizontal beds of red sandstone, silicious limestone, white sandstone and light brown sandstone, each bed being clearly distinguished from the others. In this plain is a pit about 600 feet deep and three quarters of a mile across. The edges of the beds exposed in the pit are all turned sharply upwards. The slopes of the ridge around the pit are covered with blocks and fragments of rocks like those exposed within the pit. Several years ago Mr. G. K. Gilbert made a study of Coon Butte. He appears to have supposed at first that it was formed by a meteor striking the earth. His final conclusion was, however, that it was caused by a steam explosion.

Some years ago a mining company acting upon the theory that the Coon Butte pit was made by a meteor, began a systematic search for the mass in the bottom of the crater-like depression. Their explorations show that the region has yielded several tons of meteoric iron, and that a large number of pieces of this iron have been found interbedded with the débris thrown from the pit. The distribution of the irons on the surrounding plain also lends strong support to the idea that the depression was

made by a meteor striking the earth. The bottom of the pit is filled with fossiliferous fresh-water deposits to a depth of about eighty feet.

Messrs. Barringer's and Tilghman's paper was discussed by Messrs. J. C. Branner, A. C. Lane and E. O. Hovey.

Recess was taken from 12:45 to 3:45 on account of lunch and the dedication of Rockefeller Hall.

Saturday, June 30. Excursion to Union Springs under the leadership of Professor G. D. Harris, of Cornell University. This was participated in by thirteen members of the section. The stratigraphy, paleontology and physiography of the region were studied.

Monday, July 2. An excursion by boat to various points of interest at the southern end of Cayuga Lake under the leadership of Professor G. D. Harris, which was participated in by eighteen members of the section and association. The succession of Devonian beds along the lake shores was noted; peculiarities of shore-line and delta formations observed and the erosion of the strata as exemplified in the Taughannock Falls studied. The Glenwood intrusive dike was visited.

Tuesday, July 3. An excursion to Enfield Glen under the leadership of R. H. Whitbeck of the State Normal School, Trenton, N. J., which was participated in by fifteen members of the section and association. The glacial phenomena of Cayuga Valley, the geology of the lateral valleys, the jointed structure of the rocks and the Enfield Falls, were the natural features of particular interest.

After lunch at the Enfield Glen Professor C. R. Dryer, of the State Normal School, Terra Haute, Ind., gave, by invitation, a carefully prepared paper upon 'The Geologic Features of the Finger Lake Region, New York.'

Western New York may be divided into four physiographic regions: (1) the Iroquois plain, (2) the drumlin belt, (3) the Finger Lake belt, (4) the Allegheny Plateau. The Finger Lake belt lies on the northward slope of the plateau and is trenched by numerous north-south valleys, many of which contain lakes. The valleys are long, narrow, straight or but slightly curved, flat-bottomed, from 1,500 to 2,500 deep and partly filled with sediment. The rock floor of the Cayuga Valley is 55 feet below the sea level and that of the Seneca Valley at least 556 feet. The slopes of the valley walls are smooth, symmetrical, devoid of spurs, and below the 900-foot level are sharply oversteepened. The wide, open, mature valleys of the tributary streams are, with a few exceptions, 'hung up' at the edge of the steepened slope and the streams drop by rapids and falls through narrow rock gorges, to the lake level. Enfield Creek has in its upper course a fall of about 30 feet to the mile, then it makes a nearly vertical fall of 210 feet and descends 450 feet in one mile and a half to the level of Cayuga Inlet. If the slope of the upper part be extended out into the air it would pass 500 feet above the present mouth of the stream. Within sight on the southern horizon is a notch or gap 600 feet deep and one fourth of a mile wide which leads from the head of this stream through to the Chemung drainage without any definite divide.

The physiographic problems of this region are many; but the features just enumerated can have but one meaning. Main valleys oversteepened, overdeepened and too straight and smooth to be the work of streams alone, tributary valleys hanging hundreds of feet above their immediate baselevel, a main divide notched by through-going gaps—these are as characteristic of glaciated and ice-shaped regions as

the features of Alaska, the Alps, Norway or New Zealand. In face of the fact that such peculiar, strongly marked and abnormal features always occur concordantly in regions known to have been extensively glaciated, any other hypothesis than that they are due directly or immediately to ice action of some kind seems gratuitous and impertinent. To set up such trifles as a patch of residual soil, an island in the lake, a shore cliff, etc., as competent to negative the evidences of glacial erosion is to swallow gnats and strain out a camel. A gnat may be as difficult to explain as a camel, but it is of relatively little consequence whether he is explained or not. As a means of progress across the desert of hypothesis to the oasis of conclusion, the camel may be relied on and the gnats that annoy him disregarded. The various sessions and excursions of the section were attended by thirty different members of the association.

The section finally adjourned at about 4 P.M., Tuesday, July 3.

EDMUND OTIS HOVEY,
Secretary.

SCIENTIFIC BOOKS.

Zur Erkenntnis der Kolloide. By RICHARD ZSIGMONDY. Jena, Gustav Fischer. 1905. Pp. vi + 185. 4 Marks.

The names of Siedentopf and Zsigmondy have become familiar to the whole scientific world through the brilliant researches which resulted in the development of the 'ultra apparatus'; their device for observing particles so small as almost to reach the hypothetical molecular dimensions.[1]

In this monograph, 'Zur Erkenntnis der Kolloide,' Zsigmondy has given a careful account of his own and Siedentopf's methods and results, a brief historical review of many other noteworthy researches and a short discussion of the bearing of the 'ultra' methods upon certain theoretical issues.

He states that the main purpose of his researches on colloids has been to determine whether or not the polarization and dispersion of light in Tyndall's experiment is an essential characteristic of all hydrosols or colloidal solutions. He has answered this question in the affirmative in numerous cases, having demonstrated that the dispersion of light is due to the presence of the same particles to which are to be ascribed the other remarkable properties of the liquids containing them.

It may not be amiss to state briefly the principle of Tyndall's experiment and of the 'ultra apparatus,' and to recount some of the interesting facts described in the book. A beam of light is sent through the space under observation, and the observer looks at the space in a direction perpendicular to the course of the beam. If dust, or other fine particles, are present in that space, they polarize, disperse and reflect the light, and the beam is seen. If no such particles are present, the beam is not seen, and the space is said to be optically empty.

With all the resources of the famous firm of Carl Zeiss at Jena at their command, Siedentopf and Zsigmondy constructed their apparatus to send a beam of great intensity, a minute image of the sun, into the medium under investigation, and observed through the best of microscopes. Under these conditions, the particles of metallic gold in a colloidal gold solution appear as brilliant sources of light, but their shape can not be determined.

Siedentopf and Zsigmondy counted the number of these bright spots in a space of known dimensions, they knew the concentration of the gold solution (the weight of gold per unit volume); they assumed that all the gold present was visible, that it had the same specific gravity in this finely divided state as when massive, and that the particles were cubes. From these values they easily calculated the linear dimensions of the individual particles. It will be seen at once that these dimensions can not be regarded as ascertained, because of the assumptions, but

[1] The original articles appeared in the *Zeitschrift für Elektrochemie*, Vol. VIII., pp. 684–687 (1902) and in Drude's Annalen, Vol. X., pp. 1–39 (1903).

they possess a high degree of probability. The smallest particles which they were able to count appeared to have a linear dimension of 6 $\mu\mu$ (millimicrons, or thousandths of a micron).

The extraordinary character of this achievement, actually counting such small particles, is best realized through comparisons. The smallest object visible with the best microscope has a linear dimension of about $\frac{1}{4}$ μ or 250 $\mu\mu$. The hypothetical diameter of a molecule of soluble starch has been estimated by Lobry de Bruyn at about 5 $\mu\mu$ and of a hydrogen molecule by O. E. Meyer at about 0.1 $\mu\mu$. On the other hand a human blood corpuscle has a diameter of about 7.5 μ or 7,500 $\mu\mu$. The diagrams in the book make these comparisons yet more striking.

Some solutions contain smaller particles, as is evident from the fact that the course of the light can be traced, although the individual particles can not be counted. Many solutions appear optically empty even under this searching test. We may wish to define true solutions as those which are optically empty under the 'ultra apparatus,' and colloidal solutions as those which are not optically empty under the same conditions. But there are countless intermediate steps, and these observations raise the natural question whether, after all, there is any difference between true and colloidal solutions, except in degree. That we fail to find lack of homogeneity in what we call true solutions may be due merely to the limitations of our apparatus. One naturally wonders if we may not some day, by these methods, be able to answer, in terms of fact instead of theory, those puzzling questions; in what form is a substance when in solution, and why are some things soluble and other things practically insoluble in given solvents?

Siedentopf and Zsigmondy consider it desirable to coin some new words to cover the new region which they have brought within the range of direct observation. They suggest that all particles smaller than $\frac{1}{4}$ μ shall be called ultra-microscopic particles or, for the sake of brevity, ultra-microns. These are to be subdivided into two groups, (1) those which may be counted in the 'ultra apparatus,' to be called sub-microscopic particles, submicrons, or hypo-microns, (2) those which may not be so counted, to be called amicroscopic particles or amicrons.

The sub-microns, in water solutions, possess lasting and extremely rapid oscillatory and translatory motions which differ from the typical Brownian motion in several particulars. The description of this motion, illustrated with figures, is interesting.

As is well known, we have blue solutions of colloidal gold as well as red. Zsigmondy concludes, in harmony with the majority of other authorities, that there is no observable connection between the color and the size of the particles.

Ruby glass is unquestionably to be considered as a supercooled colloidal solution. It is possible to obtain colorless 'ruby glass' by cooling, with sufficient rapidity, the solution of metallic gold in molten glass. This colorless glass, upon being heated to a temperature at which it softens, turns red. Zsigmondy devotes a good deal of space to a theoretical discussion of how the amicrons accumulate at centers to form submicrons and small crystals.

A clue is obtained to the size of the pores of filters by determining the size of gold particles which have passed through them. For instance, sub-microns of gold with linear dimensions of 30 $\mu\mu$ passed through Maasen, Pukal and Chamberland filters, which must then have some pores of that size.

The book closes with the well-justified statement that the 'ultra' methods form an important addition to, and extension of, other physical and chemical methods for the study of conditions which have hitherto escaped direct observation. It can not be considered an exhaustive review of the whole subject of colloids. Lottermoser's 'Ueber anorganische Colloïde' in the sixth volume of Ahren's Sammlung chemischer und chemisch-technischer Vorträge is a more complete summary of the literature. But Zsigmondy has given us an eminently satisfactory, and most welcome treatise on the 'ultra' methods, and the

deeply interesting results obtained by them. Moreover, it is suggestive of many possibilities of future discovery.

S. Lawrence Bigelow.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Experimental Zoology, Vol. III., No. 2 (July, 1906), contains the following articles: 'Observations and Experiments Concerning the Elementary Phenomena of Embryonic Development in *Chætopterus*,' by Frank R. Lillie. This is a study of the origin and behavior of formative stuffs in the early development of an annelid by direct observation, and by various experiments, *e. g.*, analysis by centrifugal force, by staining intra vitam, and by suppressing the process of cleavage without prejudice to other embryonic processes. The standpoint is that a complete account of embryonic development would trace everything back to the chromosome complex of the species. 'Regeneration of Grafted Pieces of Planarians,' by Lilian V. Morgan. A complete head may regenerate from a posterior cut surface of planarians if a very short piece is grafted in a reverse direction on a larger piece. 'Experiments on the Behavior of Tubicolous Annelids,' by Charles W. Hargitt. 'Inheritance of Dichromatism in *Lina* and *Gastroidea*,' by Isabel McCracken, Stanford University. In this paper the author records the results of an attempt to determine the behavior in heredity of the alternate characters in dichromatic species. Two dichromatic beetles, *Lina lapponica* and *Gastroidea dissimilis*, were bred under controlled conditions through a series of generations, four in the former, seven in the latter. The investigator finds an accumulative dominance of one color over the other from generation to generation, or a prepotency of the dominating color that apparently eventually eliminates the recessive color from the dominant line. The recessive color behaves like a typical Mendelian recessive.

DISCUSSION AND CORRESPONDENCE.

WHEN DID FRANKLIN INVENT THE LIGHTNING-ROD?

The bi-centenary of Benjamin Franklin's birth has served to recall attention to the varied achievements of this remarkable man, but it would hardly be expected that new facts could be learned regarding the invention of the lightning-rod, upon which his popular fame as a natural philosopher chiefly rests.

Franklin's classic experiment with the electrical kite, by which he demonstrated the identity of lightning and artificial electricity, was performed at Philadelphia during the summer of 1752. The date June, which is frequently quoted, seems to have been authorized by Priestley in his *History of Electricity*. On the contrary, his French contemporary, De Romas, who claimed the idea of the electrical kite, maintained that Franklin did not fly his kite in June, nor until after he had heard of the success of the French experimenters, Dalibard and Delor, who, in May, 1752, collected the electricity during a thunderstorm by metal rods, according to a method which he himself had suggested. Authorities differ as to whether Franklin knew of this when he obtained the same results with his kite, Park Benjamin, on page 589 of his 'Intellectual Rise in Electricity,' asserting that Franklin desired to confirm the French experiments. If this be true the kite experiment could hardly have been executed at Philadelphia so soon as the following month, that is in June, but, at all events, no mention of it occurs anywhere until a letter describing it, written there in October to Peter Collinson at London, was read before the Royal Society on December 21, 1752. This communication, which appeared in the *Gentleman's Magazine* for December, 1752, and in the *Philosophical Transactions* for the same year, was reprinted with Franklin's 'Experiments and Observations in Electricity,' of which the second part of the first edition was published at London in 1753. While it seems to have passed unnoticed that the letter describing the electrical kite in the *Philosophical Transactions* is dated October 1 and the same letter in the collected papers bears the date October 19, a date subsequently adopted by his biographers, it was reserved for a German bibliographer, Professor Hellmann, to point out, in publishing a facsimile of this

letter from the *Philosophical Transactions,* in No. 11 of *Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus* (Berlin, 1898), that an important omission had been made in the slightly different version printed in the collected papers. The present writer finds that this error has been perpetuated by such careful biographers of Franklin as Sparks, Bigelow and Smyth, who, having reprinted the letter from the collected papers, also omit this concluding paragraph:

I was pleased to hear of the success of my experiments in France, and that they there begin to erect points upon their buildings. We had before placed them upon our academy and statehouse spires.

Professor Hellmann supposes that Franklin, by the last statement, wished to claim priority in the use of pointed rods as lightning conductors.

Already in his 'Opinions and Conjectures Concerning the Properties and Effects of the Electrical Matters, arising from Experiments and Observations made at Philadelphia, 1749,' contained in a letter to Peter Collinson, dated July 29, 1750, Franklin had proposed to test the electricity of thunder-clouds and had suggested the possibility of the lightning-rod. In order to continue his experiments, Franklin, in September, 1752, erected on his house an insulated iron rod, connected at its lower end with a pair of bells which, by ringing, would show that the rod was electrified. On April 17, 1753, he charged one Leyden jar from this rod and another jar with positive electricity from a frictional machine, concluding from this and subsequent experiments

That the clouds of a thunder-gust are most commonly in a negative state of electricity, but sometimes in a positive state.

Further on in the same letter in which the preceding experiments were described, written at Philadelphia in September, 1753, Franklin says:

Metalline rods, therefore, of sufficient thickness, and extending from the highest part of an edifice to the ground, being of the best material and complete conductors, will, I think, secure the building from damage, either by restoring the equilibrium so fast as to prevent a stroke, or by conducting it in the substance of the rod so far as the rod goes so that there shall be no explosion but what is above its point, between that and the clouds.

This is generally believed to be the first definite announcement of the lightning-rod, although Poggendorff, in his 'Geschichte der Physik,' page 867, casts doubt on Franklin's sole claim to its invention by saying that J. H. Winkler, of Leipzig, in his 'Programma de avertendi fulminis artificio,' Lipsia, 1753, recommended the use of lightning conductors and gave directions for their erection, in consequence of which, probably, they were first introduced into Germany in 1754.

I shall show, however, by what follows that Franklin had prepared detailed instructions for the installation of lightning-rods nearly a year before he wrote the letter that has just been quoted. In *Poor Richard's (Improved) Almanac* for 1753, edited by Richard Saunders (Benjamin Franklin's pseudonym) and published in Philadelphia by B. Franklin and D. Hall, the material for which must have been ready not later than October, 1752, occurs the following remarkable article which seems to have entirely escaped the attention of Franklin's biographers and of scientific students generally.

How to secure Houses, &c. from Lightning. It has pleased God in His Goodness to Mankind, at length to discover to them the Means of securing their Habitations and other Buildings from Mischief by Thunder and Lightning. The Method is this: Provide a small Iron Rod (it may be made of the Rod-iron used by the Nailers) but of such a Length, that one End being three or four Feet in the moist Ground the other may be six or eight Feet above the highest Part of the Building. To the upper End of the Rod fasten about a Foot of Brass Wire, the size of a common Knitting-needle, sharpened to a fine Point; the Rod may be secured to the House by a few small Staples. If the House or Barn be long, there may be a Rod and Point at each End, and a middling Wire along the Ridge from one to the other. A House thus furnished will not be damaged by Lightning, it being attracted by the Points and passing thro the Metal into the Ground without hurting any Thing. Vessels also,

having a sharp pointed Rod fix'd on the Top of their Masts, with a Wire from the Foot of the Rod reaching down, round one of the Shrouds, to the Water, will not be hurt by Lightning.

From the foregoing it is evident that Franklin drew up definite instructions for erecting lightning-rods before the close of the year 1752 and from the contemporaneous letter, describing the electrical kite, it would appear that at this time some edifices in Philadelphia were thus equipped, but whether for their protection or for experiment is uncertain.

A. Lawrence Rotch.
Blue Hill Meteorological Observatory,
August 13, 1906.

DRIED COTTON CULTURES ONCE MORE.

It would appear from a recent communication in Science that the original dictum of Messrs. Harding and Prucha that the nodule-forming bacteria will not survive when dried upon cotton is now to be modified to apply only to those cultures dried (?) in a Petri dish enclosed in a paper bag and stored in a drawer or under conditions considered to be similar to this. Although an attempt is made to show that such a method closely resembles that used in the original preparation of cotton cultures, the actual difference in drying time will be so evident to any one who cares to try the experiment that it need not be discussed here. Indeed, it would hardly seem necessary to demonstrate the fact that of two pieces of cotton containing the same amount of moisture, one enclosed in a Petri dish, and the other exposed to the action of an abundance of warm air, the one in the air will dry much sooner than the protected piece. One would as readily expect clothes to dry as rapidly enclosed in a box, wrapped in paper and put away in a drawer as when hung upon a line. In fact it was this very question of rapidity of drying which caused the various 'germ-proof' methods of preparing the cotton to be abandoned. It was found that even in a specially constructed box of large size (approximately 8 x 2 x 2 feet) through which air was forced over a warm coil, that the length of time required for drying was entirely too long, and for practical purposes, considering the way in which the cultures were to be used, it was better policy to turn out a culture which might be more or less contaminated than to destroy the nodule-forming bacteria in an attempt to produce a pure culture. Experiments showed that all attempts, with the facilities available, to produce absolutely pure cultures upon cotton involved an unwarranted sacrifice of efficiency.

It has been supposed that the result obtained by the users of the dried cotton cultures would of itself be a sufficient refutation of the statement that dried cotton cultures were valueless. This seems to be the case since an attempt is now made to explain the reports received by users of the cultures upon 'psychological' grounds.

If the bacteria will not live upon cotton it is of course necessary to account in some way for the thousands of satisfactory reports received from this country and elsewhere, and the psychological explanation would seem to be as good as any. It should be remembered, however, that many of the favorable reports were furnished by those fully as competent to judge of the results obtained as a member of an experiment-station staff—that a considerable number of these experiments were checked by uninoculated plots and that photographs showing the difference between these treated and untreated plots are available in all cases where it was possible to obtain them. Furthermore, the reports covered tests with sterilized soil and sand as well as field experiments.

Since the publication of a few of the favorable reports first received, there have been many others which emphasize even more strongly the benefit derived from cultures when used under the conditions for which they are designed. During the past season, while the statement that the cotton cultures were valueless was very widely published, producing, one would suppose, anything but a favorable psychological effect, most satisfactory reports continued to be received.

Although it is manifestly impossible in this statement to refer directly to any of these reports, it may not be out of place to cite

briefly the results obtained with dried cotton cultures in competition with pure cultures on agar obtained from Hiltner of Munich, by the Board of Agriculture of Great Britain. This test was conducted by thirteen different agricultural colleges and experiment stations during the year 1905. The general plan of the experiment was as follows:

1. Laboratory experiments with sterilized soil and sand.

2. Pot cultures in unsterilized soils from various sources.

3. Experiments in accord with actual agricultural or horticultural practise.

The results of these experiments are published in detail, and to any one examining them it can not but be evident that the contention that the nodule-forming bacteria properly dried upon cotton will not live is entirely erroneous. In spite of the fact that the cotton cultures were in some instances a year old and had undoubtedly been subjected to various unfavorable conditions, there was no advantage whatever in the Hiltner fresh pure culture over the dried cotton culture. The conclusion reached by the board speaks for itself:

The experiments in which positive results were obtained show that in many cases both Moore's and Hiltner's cultures were alive, and capable of infecting the plants for which they were designed and producing an increased yield.

Concerning the statement that no United States experiment station has been able to obtain 'good results' from dried cotton cultures it would seem that in view of the results obtained either by experiment stations, or under government supervision, in Great Britain, Australia, New Zealand, South Africa, China and other foreign countries—to say nothing of the unquestionable ability of those reporting success in this country—that the 'psychological' explanation should be applied to the experiment station reports rather than to those obtained from successful users of dried cotton cultures. Furthermore, an analysis of the reports from those experiment stations which I have had an opportunity to examine does not reveal the worthlessness of the cultures which it seems so desirable to demonstrate, and finally it is not an impossibility that under the circumstances the experiment station may not be the final court of appeal in such a matter, after all. One would hardly expect 'any well-marked result' from a culture which, after being prepared, was carefully kept upon ice until ready for use—a method actually employed at one of the experiment stations.

The question of the vitality of nodule-forming bacteria in dried cotton cultures is one that can not be settled by an attempt to explain away the actual results which can be and have been obtained from their use. The incompatibility of these results with the idea that the bacteria are killed by drying is admitted, but it is not the results which will have to fall. I shall be glad to send dried cotton cultures to any one who may wish to arrive at an independent conclusion regarding the ability of the nodule-forming bacteria to withstand drying. These cultures may be retained any length of time up to twelve months before testing, so there will be no question about the period during which vitality is retained. The inoculated cotton will have been dried in a room through which a current of air has been forced, not in a Petri dish.

GEORGE T. MOORE.
MARINE BIOLOGICAL LABORATORY,
WOODS HOLE, MASS.,
July 28, 1906.

SPECIAL ARTICLES.

GEOLOGY OF SOUTH BRAZIL.

[THE following note from Dr. I. C. White, chief of the Brazilian Coal Commission, should have appeared in connection with the communication of Professor Osborn on 'Vertebrate Paleontology,' published in the issue of SCIENCE of August 3, but was received too late for insertion in that issue.]

Mesosaurus Brasiliensis occurs in the Iraty black shale, state of Paraná, a formation whose base lies about 100 meters above the Brazilian Coal Measures which hold the typical Glossopteris flora of the Ecca series of South Africa, and the Karharbari series of India. It is

also the same horizon at which Dr. Derby finds *Stereosternum tumidum* in the state of São Paulo, and its geological horizon is approximately 300 meters below the *red beds* that hold reptilian remains (*Scaphonyx fischeri*) which Dr. A. Smith Woodward of the British Museum regards as closely related to *Euskelesaurus* of the Stormberg, or Triassic beds of South Africa. In fact, it appears that we have in Brazil a series of rocks which correlate closely with the Karroo system of South Africa, and that glacial conditions also existed in Brazil immediately preceding the deposition of the Coal Measures there, during the epoch of the Orleans Conglomerate which corresponds to the 'Dwyka,' and 'Talchir' conglomerates of Africa and India. The following scheme of classification, which I have adopted for the beds near Minas, Santa Catharina, will give a general idea of the stratigraphic succession in that state.

Santa Catharina System:	São Bento Series:	Serra Geral eruptives.
		Botucatú sandstones, great cliffs of red, gray and cream-colored sandstones.
		Rio do Rasto red beds, with fossil reptiles (*Scaphonyx*) and fossil trees.
	Passa Dois Series:	Rocinha limestone.
		Estrada Nova gray and variegated shales with cherty concretions, and sandy beds.
		Iraty black shale, *Mesosaurus* and *Stereosternum*.
	Tubarão Series:	Palermo shales.
		Rio Bonito shales and sandstones, with Coal Measures and *Glossopteris* (*Gangamopteris*) flora.
		Orleans conglomerate.
		Yellow sandstones and shales to granite floor.

The Tubarão and Passa Dois series would correlate with the Ecca series, or Lower Karroo, of South Africa, while the São Bento beds would represent the Stormberg, or Upper Karroo series. The fossils of the Beaufort or Middle Karroo series have not yet been discovered in South Brazil.

Mr. David White, of the United States Geological Survey, to whom was entrusted the study and description of the fossil plants collected from the rocks of the Santa Catharina system by the Brazilian Coal Commission, finds the typical *Glossopteris* flora in the collections from the Tubarão and Passa Dois series, and assigns both to the Permian. This conclusion is shared by the writer except that he thinks it possible the Coal Measures or Rio Bonito beds of the series given above may be of Permo-Carboniferous or Artinskian age, while all above them to the base of the São Bento series would be true Permian, and this would of course include the *Mesosaurus* zone. The very interesting and elaborate memoir of Mr. David White, illustrated with ten plates of fossil plants, will be published, along with Dr. J. H. McGregor's valuable memoir on *Mesosaurus brasiliensis*, in my final report to the Brazilian government on its coal resources. The name 'Gangamopteris flora' is preferred to that of 'Glossopteris flora' by Mr. David White for reasons that he fully explains in connection with his description of this interesting flora.

The following quotation from Mr. David White's manuscript, giving the list of species, will prove of much interest:

> That the flora of the Brazilian coal measures is composed of mingled older Gondwana and Northern Permian species has long been known. The presence of Gondwana elements in Brazil was recognized by Hettner; and Zeiller has contributed a very valuable discussion of the intermingling of Northern and Southern types, and of the consequent deductions as to the boundaries of the two great floral provinces in Permo-Carboniferous time. In the following pages it will be shown that we have in southern Brazil a typical Lower Gondwana flora, embracing the principal types characteristic of that flora in India, Australia and South Africa, to which is added a smaller part, chiefly composed of Lepidophytes, derived more or less directly from the Northern Permo-Carboniferous flora. Also

it will be seen that the Gondwana forms were present in the lowest sediments of the series, while the Northern elements, appearing a little later, seem to become more abundant and varied in the higher beds.

The total flora, so far as yet discovered, is in the following

LIST OF THE FOSSIL PLANTS FROM THE COAL-FIELDS OF BRAZIL.

Reinschia australis Bert. & Ben., var. *brasiliensis* n. var.
Rosellinites Gangamopteridis n. sp.
Hysterites brasiliensis n. sp.
Equisetites calamitinoides n. sp.
Schizoneura? sp.
Phyllotheca Griesbachi Zeill.
Phyllotheca Muelleriana n. sp.
Phyllotheca (*?*) sp.
Lycopodiopsis Derbyi Re.
Lepidodendron Pedroanum (Carr.) Zeill.
Lepidophloios laricinus Sternb.
Sigillaria Brardii Brongn.
Sigillaria australis n. sp.
Sigillaria sp.
Sigillaria (*?*) *muralis* n. sp.
Sphenopteris hastata McCoy?
Sphenopteris sp.
Psaronius brasiliensis Brongn. (Not represented in the collection.)
Neuropteridium Plantianum (Carr.) D. W. (Not represented in the collection.)
Glossopteris Browniana Brongn.
Glossopteris indica (Brongn.) Schimp.
Glossopteris ampla Dana.
Glossopteris occidentalis n. sp.
Glossopteris sp.
Vertebraria sp.
Gangamopteris obovata (Carr.) D. W.
Ottokaria ovalis n. sp.
Arberia minasica n. g., n. sp.
Derbyella aurita n. g., n. sp.
Nœggerathiopsis Hislopi (Bunb.) Feist.
Cardiocarpon Seixasi n. sp.
Cardiocarpon Moreiranum n. sp.
Cardiocarpon Oliveiranum n. sp.
Cardiocarpon Barcellosum n. sp.
Voltzia? sp.
Dadoxylon Pedroi Zeill.
Dadoxylon nummularium n. sp.
Dadoxylon meridionale n. sp.
Carpolithus? sp.
Hastimima Whitei n. g., n. sp.

Although the number of forms, forty in all, is not large, it will at once be noted that it embraces representatives of the four dominant and characteristic groups of the older Gondwana flora; namely, *Phyllotheca*, *Glossopteris*, *Gangamopteris* and *Nœggerathiopsis*, all of which are present in identical oriental species.

I. C. WHITE.

MORGANTOWN, W. VA.,
August 1, 1906.

THE FOREST DISTRICTS OF UGANDA.

A journey of inspection through the most important forest areas of the Uganda protectorate has lately been made by Mr. M. T. Dawe, officer in charge of the forestry and scientific department, who gives the results of his observations in a parliamentary paper, according to the abstract in *The Geographical Journal*. The largest forests (as shown in a sketch-map accompanying the report) lie along two strips of country, one running near the west and northwest shores of the Victoria Nyanza, the other following a more or less parallel line through the extreme west of the protectorate. Mr. Dawe describes each forest in turn, and though his point of view is mainly economic, many details of scientific interest can be gleaned from the report. A discovery was that of the Lagos silk rubber tree (*Funtumia elastica*) as an indigenous element, while several new species of *Landolphia*, some of economic importance, were also brought to light. Of the first forests visited, that of Bujeju in Buddu occupies a low-lying tract near the lake, some parts of which seem once to have formed part of the latter. The forest seems comparatively new, and to be gradually encroaching on the interior plains. It contains no good rubber-vines, though they are found in adjoining areas. One of the trees found in this district, though not of large size, is a variety of the valuable *Podocarpus milanjianus*, which occurs practically on the lake-shore. Of the western forests, that of western Ankole occupies a large area east of Lake Albert Edward. It is largely composed of three trees—*Carapa grandiflora*, *Symphonia globulifera* and *Parinarium excelsum*. Mr. Dawe remarks that almost every forest in Uganda possesses its own special character,

due to the predominance of one or two particular trees. In Toro, the Kibale forest covers a considerable area. The most common tree is one nearly allied to *Maba abyssinica*, with ebony-like markings in the center. An interesting tree with resinous bark and a timber much resembling sandal-wood proved to be unknown, and has been placed in a new genus (*Dawea*), as well as in a new tribe of *Bixineæ*. To the south this forest touches the northern end of Lake Ruisamba. An account is given of the types of vegetation on the Ruwenzori range, agreeing generally with those of previous travelers, though more detailed as regards species met with. Here, too, the *Podocarpus milanjianus* occurs. The tree-*Senecio* growing near the lower glaciers proved to be a new species, which has been named *adnivalis*. From the point reached near the base of the glacier no snow was visible (in July), and Mr. Dawe concludes that there are much colder seasons. The country comprising the Semliki plains, with the Ruwenzori and Mboga ranges on either side, is described as one of the finest districts for cultivation in the protectorate, the hot Semliki valley being especially adapted for tropical products, such as Para rubber. The climate of the Mboga hills seems more bracing than that of Ruwenzori. In the Semliki forest (which is largely composed of *Cynometra*), the oil palm of West Africa is found, and is said to be abundant in certain localities. The Bwamba of this region are very destructive to forest land, as they are constantly making new clearings. In the Bugoma forest of Unyoro the *Cynometra Alexandri* is again abundant, and where this is the case there is little rubber. Further north, the Budongo forest is said to cover an area of 350 square miles. It is well watered. The growth of trees is very dense, and it is the most valuable timber forest seen in the protectorate, the most important trees belonging to the mahogany order. Unyoro is regarded by Mr. Dawe as offering great possibilities for agriculture, and as admirably adapted for cotton so far as the soil is concerned.

APPOINTMENTS AND REMOVALS AT STANFORD UNIVERSITY.[1]

It is believed by the president and members of the board of trustees that the vesting of the power of removal of members of the university solely in the hands of the president in accordance with the original deed of grant is an arrangement not desirable as a permanency in university management. Furthermore, there seems no good reason why appointments, promotions and removals should not stand on the same footing. In view of this, the following resolution was adopted by the board of trustees of the university, on March 30, 1906, with the full approval of the president. This resolution, although properly belonging to the report for 1906–07, is on account of its importance incorporated here, the delay in printing the present report making this possible.

Whereas, It is desirable that all nominations for appointments and promotions of members of the teaching staff at the university, and all recommendations for dismissals, should be made by or through the president of the university, the board of trustees taking no initiative in these matters, and

Whereas, It is undesirable that either the power of appointment or removal should rest absolutely in the hands of a single person,

It is Resolved and agreed by the board of trustees and president of the Leland Stanford Junior University that so long as nominations for appointments and promotions of members of the teaching staff of the university are made by or through the president of the university, no dismissal shall be made without the concurrence of a majority of the trustees present at a meeting of the board of trustees at which a quorum shall be present.

That in the case of the recommendation of the removal of a member of the teaching staff involving any questions affecting his honor or moral character, he shall be furnished by the president, upon application, with a specific written statement of all charges and evidence reflecting upon his honor or moral character, and be given an opportunity to present a written statement of his answer and of any evidence he may wish to offer in defense, and a copy of all such charges and evidence, together with any answer and evidence

[1] Concluding part of the annual report of President David Starr Jordan.

offered by the accused, and the recommendations of the advisory board shall be attached to the recommendation of the president of the university, and the action of the board of trustees shall be based solely upon the recommendation of the president of the university and the record attached thereto, there being no further hearing before the board of trustees or any member thereof, unless the board in its discretion shall elect to receive other evidence in aid of its decision, and any such recommendation and information affecting the honor or character of a member of the teaching staff shall be presented to and acted upon by the board of trustees separately from anything which may involve his competency or fitness in any other respect. The members of the board shall not in any case, or in any event, listen to or receive any statement concerning such matter except in open meeting.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR IVAN PETROVITCH PAVLOFF, professor of physiology in the University of St. Petersburg, will deliver the Huxley lecture at the Charing-cross Hospital Medical School on October 1.

THE annual address before the Sigma Xi Society of the University of California was given on September 4 by Professor H. S. Jennings, of Johns Hopkins University, on the subject 'The Behavior of Some Animals of the Seashore.'

DR. S. KIMURA, professor in the Imperial Japanese Navy, is passing through this country on his way to Berlin, Germany, where he will attend the wireless telegraph conference.

MR. W. MARCONI expected to sail for this country on September 15, on the *Caronia*.

DR. LAWRENCE F. FLICK, director of the Phipp's Institute of Philadelphia, was one of the delegates to the Congress on Tuberculosis which met during the first half of the present month at The Hague.

PROFESSOR D. S. JACOBUS, who has been connected with the Stevens Institute of Technology since 1884 as instructor and professor of experimental engineering, has resigned to join the technical staff of the Babcock and Wilcox Boiler Company.

DR. L. A. BAUER'S resignation from the U. S. Coast and Geodetic Survey took effect on September 1. As already announced in this journal, he has accepted the permanent directorship of the department of terrestrial magnetism of the Carnegie Institution of Washington. All his correspondence should be addressed to The Ontario, Washington, D. C.

DR. HARRY T. MARSHALL, formerly of the Johns Hopkins University, has been appointed pathologist at the Bureau of Science at Manila.

DR. J. STEIN, S.J., has been appointed astronomer in the Vatican Observatory at Rome.

ACCORDING to the *Journal of the American Medical Association*, it is rumored that Professors von Leyden and Olshausen intend to retire from the medical faculty at Berlin University. Professor E. v. Bergmann will also give up further teaching this fall when he passes his seventieth birthday, and Professor W. Erb, of Heidelberg, will retire at the close of the winter semester.

DR. ELMER E. BROWN, recently appointed U. S. commissioner of education, will give the opening address at the exercises of the School of Pedagogy of New York University, on September 22.

AT the recent Boston meeting of the American Academy of Medicine, Dr. Casey A. Wood, of Chicago, was elected president. Dr. F. Trendelenburg, professor of surgery at Leipzig, who was in attendance at the meeting, was elected an honorary member.

THE Simon Fund of $25,000 for the furtherance of research on syphilis has been divided between Professor Neisser, of Breslau, who receives $19,000; Dr. J. Siegel, who receives $4,500, and Dr. Lesser, to whom $1,500 has been awarded.

HERR O. WENTZKI, of Frankfurt a. M., has been awarded the 300-marks prize of the Berufsgenossenschaft der chemischen Industrie for the discovery of the best means of purifying hydrogen which contains arsenic.

AT the meeting of the Association of Military Surgeons, held in Buffalo last week, it was announced that the Enno Sanders prize had been awarded to Major Pilcher for an

essay on 'The training of the medical officer of the state forces to best qualify him for local service and for mobilization with national troops.'

Professor Chas. N. Gould is preparing a preliminary report on the oil, gas and coal deposits of the new state of Oklahoma. The field work was accomplished during July and August.

The Journal of the American Medical Association states that a memorial tablet was recently unveiled at Pavia, Italy, to the memory of the late surgeon, E. Bottini. Behind the tablet were immured a gold medal with the portrait of the deceased and an elaborate souvenir volume containing works by his pupils and friends, with an address on parchment—all of which had been prepared to present to the master on the occasion of the twenty-fifth anniversary of his assuming the chair of surgery at Pavia. The plans for the ceremonies were annulled by the unexpected death of the great surgeon not long before the arrival of the anniversary. The tablet stands between one erected to the memory of Scarpa and another to Porta, and the inscription on the marble is merely a few words of tribute to the man 'who by his genius in the science and the art renewed the glorious traditions of the Pavia school of surgery.'

M. Joseph François Bossert, astronomer at the Paris Observatory, has died at the age of fifty-four years.

Dr. Max von Eyth, known as an engineer and author, died on August 21 at Ulm, at the age of seventy years.

Dr. John Cameron, consulting physician to the Royal Southern Hospital, and formerly lecturer on medicine at the Liverpool Royal Infirmary, has died at the age of eighty-eight.

There will be on October 17 a civil service examination for the position of scientific assistant in the Department of Agriculture, at salaries ranging from $840 to $1,200 per annum, depending upon the qualifications and experience of the appointees. Attention is invited to the fact that it is especially desired to secure application for the major optional subjects—analytical chemistry (methods for the detection of food adulteration), plant pathology and soil physics.

The Illinois Civil Service Commission announces examinations for a pathologist at Kankakee ($2,500 a year and maintenance), and pathologists in six other hospitals for the insane.

The Mexican government offers three prizes, each of the value of $20,000, for (1) the discovery of the typhus fever germ; (2) the mode of its transmission to man; (3) a successful preventive or curative serum or other effectual remedy.

Professor A. D. F. Hamlin, of Columbia University, has been authorized to offer a prize of $500 in behalf of the American Society for the Prevention of Cruelty to Animals for the best design for a bronze drinking fountain for dogs, horses and men. It is to be set on the edge of the sidewalk. Each fountain is to be limited in cost to $250.

An association for the study of microbiology has recently held its first session at Berlin.

The first international congress for the study of the polar regions opened on September 7 at the Palais des Académies, Brussels, under the presidency of M. Beernaert. As the London *Times* states, the idea of the systematic study of this portion of the globe originated in the international congress on 'expansion mondiale' held last year at Mons, when a committee was formed to carry the idea into practise on a basis of international cooperation. At the meeting representatives were present from the institutions and learned societies of almost every quarter of the globe. Among those present were Dr. Nordenskjöld, M. Arctowski, M. de Gerlache, Captain Scott, Prince Buonaparte, and many leading men of science. Baron de Favereau, the Belgian minister for foreign affairs, welcomed the delegates. It was decided to form a committee to study the best means of creating an international polar association for the purpose of organizing explorations and otherwise assisting the object in view. Dr. Jean Charcot announced that he was organizing an expedi-

tion to the South Pole and Charles Benard, president of the Belgian Oceanographic Society, said that society was organizing an expedition to the North Pole.

The British Medical Journal says in an editorial article: "In regard to yellow fever, Panama affords as striking an object lesson as Havana of the incalculable benefit to mankind that has followed the discovery of the cause of the disease and the manner of its transmission. The glory of the work which has had this striking consummation is shared by several men. The credit of the conception belongs to Dr. Carlos Finlay, who propounded the idea many years ago without attracting from the profession any attention but an occasional contemptuous notice. More fortunate than many true begetters of new truths, Dr. Finlay, at the meeting of the Pan-American Medical Congress held at Havana in 1901, was acclaimed by the assembly as the author of the discovery which has already been so fruitful of good effects. Dr. Carter was another pioneer in the work which was brought to completion by the American Commission. Untimely death snatched the reward from the hands of Walter Reed and Lazear, but Drs. Carroll and Agromonte still survive. It would, we think, be a fitting acknowledgment of the work of these four men if the Nobel prize were divided among them. It will scarcely be denied by any one conversant with the facts that their work is of far greater importance than that of several to whom the prize has been awarded in the past few years. The only original research work whose practical results can be held to compare with it is that which has brought malaria, that monster which till lately claimed so vast a tribute of human lives, within the control of man."

The Geographical Journal states that a new railway just opened in China traverses a fertile and populous tract of alluvial country in the province of Kiangsu. It runs for a distance of about 200 miles from Shanghai to Nanking in a generally northwesterly direction through the towns of Su-chou, Wu-sieh and Chin-kiang. The section actually opened to traffic, however, is from Shanghai to Su-chou and Wu-sieh, a total distance of 85 miles. The remaining portion to Chin-kiang and Nanking enters into more hilly country, where some tunnelling is necessary, and this, it is anticipated, will not be completed and opened for traffic until 1908. The country round about is one of the most thickly inhabited and productive parts of China. It is intersected with numerous creeks, canals and tributary streams draining into the Su-chou Creek, the Hwang Pu River and the Yang-tse Kiang. Cotton, rice and mulberry trees are grown extensively, and there is a great passenger traffic along the Grand Canal, as well as endless junks freighted with timber, stone, grain, pottery, bamboos and miscellaneous goods. The length of time occupied by passengers in traveling from Shanghai to Nanking will be reduced from about twenty-eight hours to eight or ten hours, and the goods traffic, which now occupies several days, will gain in an even greater degree. Su-chou and Chin-kiang, in addition, of course, to Shanghai and Nanking, the termini of the line, are treaty ports. The first named has been called the Venice of the Far East, owing to the network of canals that pass through its curious narrow streets. It was besieged by Colonel Gordon during the Taiping rebellion, and is now a great center of the silk industry. Wu-sieh and Chin-kiang are also busy marts, the latter, as well as Nanking, being a regular calling place for the steamers that ply on the Yang-tse.

WE learn from the London *Times* that a large collection of South American birds has been presented to the Zoological Society by Captain Pam, who brought them with him from Caracas. At the wish of the donor, Mr. Thomson met the mail boat at Southampton and took charge of the birds, which he conveyed to the gardens without any losses. To Captain Pam belongs the credit of being the first person to introduce any species of the humming-bird family to the Regent's Park aviaries. Last November he presented one of the 'violet ears' (*Petasophora iolata*), the only survivor of the half-dozen with which he started, and the bird lived for a fortnight,

though it suffered badly from the cold during the latter part of the passage, and footwarmers were used to provide artificial heat for it on the train journey. Short as the life of this example was in captivity, it exceeded by some days that of others kept by a private aviculturist in Gray's-inn, who a few years ago purchased eleven, and lost them all within as many days. The humming-birds which arrived on Monday have been placed in the insect-house, one end of which is now occupied by two large glass cases specially prepared for them, and quite large enough to allow of somewhat extended flight. On their passage to England the birds were fed, as they will be at the gardens, on meat extract mixed with honey, the former being intended to make up for the insects which they obtain in a natural condition, but which are difficult to supply in captivity. Even in South America native-born aviculturists reckon themselves successful if they keep a caged humming-bird for a couple of months. This period, however, was doubled by Captain Pam, who had one of these birds for four months. These newcomers have not yet been identified, but it is believed they are closely allied to the violet-eared humming-bird exhibited last November. The insect-house was closed to the public on Monday, but it will soon be open again, and the tropical birds kept there should prove a great attraction. Much more numerous was the other part of the collection, which has been deposited for the present in one of the inner rooms of the western aviary. The only one that has yet been turned out of the traveling cage is a sun-bittern, none the worse for its journey. The other species, of which there were in all over eighty examples, consisted of maroon and blue-shouldered tanagers, golden-crowned harynests, mocking birds, a small woodpecker (new to the collection), hooded siskins, buntings and finches.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of Edward H. Dunn, president of the corporation of Boston University, $120,000 is left to that institution, one half for the establishment of a professorship and one half for general purposes.

We learn from the *Medical Record* that the Medical College building in connection with Queens University, Kingston, was destroyed by fire recently. Although there was an insurance of only $22,000 steps were immediately taken to erect a new building, which it is expected will be ready for use early in October. The fire, it is thought, originated from a gas jet kept burning in an oven where paraffine molds were made. The destruction of the bacteriological and public health laboratories in connection with the college will for the present cause considerable inconvenience.

At the last meeting of the regents of the University of Nebraska, Dr. F. E. Clements was promoted from the associate professorship of plant physiology to the full professorship.

Ensign C. A. Harrington, U.S.N., who graduated from the Naval Academy two years ago, has been assigned to give a course in naval architecture at the Massachusetts Institute of Technology.

Mr. Frank F. Grout, A.B. ('04, Minnesota), has resigned from the Illinois Geological Survey to accept a position as instructor in mineralogy at Oklahoma State University.

Appointments in philosophy and psychology are announced as follows: Mr. Rowland Haynes, assistant in philosophy at Columbia University during the winter of 1905–6, has been appointed associate in philosophy at the University of Chicago for the ensuing year. He is to have courses in philosophy, ethics, psychology and logic during the absence in Europe of Associate Professor A. W. Moore. Dr. Harvey Carr, of the University of Chicago, has been appointed instructor in psychology in the Pratt Institute of Brooklyn, to succeed Dr. Irving King, who goes to the University of Michigan. Dr. W. K. Wright, of the University of Chicago, has been appointed instructor in philosophy and psychology in the University of Texas, to succeed Dr. Warner Fite, who has accepted a call to the University of Indiana. Dr. Percy Hughes, instructor in philosophy at the University of Minnesota, will give the courses at Tulane University during Professor W. B. Smith's absence in Europe.

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SOME PROBLEMS FOR AGRICULTURAL CHEMISTS.[1]

THE topic of my paper is not intended to convey the idea that I have anything new or startling to suggest, or that I intend to point out the shortcomings of the American agricultural chemist. My purpose is mainly to state what an experience of twenty-five years has suggested in the way of chemical investigations that seem now to be essential, if we are to maintain, or increase, the fertility of our soils, and thus retain the position that we have acquired as an agricultural people. We have in this country quite as capable chemists, I am sure, as there are in any country, yet the conditions existing here in the past, and that do exist now, in a way, have been such as to demand that our agricultural chemists should follow lines of a semi-technical, rather than of an investigational, character, in the sense that they have necessarily applied themselves to the problems of crop utilization, rather than to those having to do with the principles involved in their production. The principles of agricultural chemistry, which the early investigators established, and which were collated and formed into a science by the aid of the immortal Liebig, have served as the foundation for our work, and this basis has been sufficient to enable us to make great progress from the economic standpoint, so long as there were, in a sense, new worlds to conquer and new

[1] An address delivered before the American Chemical Society at the Ithaca meeting.

fields to cultivate, but do not fully serve when the rich stores of fertility in our fields have been, in part, exhausted.

In the next place, the conditions that existed here in the earlier history of our country, were not such as to demand on the part of the tiller of the soil, or farmer, a knowledge of those principles which would enable him to utilize to the best advantage soil fertility, and when the time came (as it has now for a large portion of our country), when knowledge of principles became a necessity, in order that farming on these areas might be made profitable, the first duty of the chemist was to rather demonstrate the usefulness of an application of the chemical knowledge already available. That is, the chemist became a teacher, rather than an investigator, and the results of his work have been altogether good. There is now a wide knowledge of underlying principles, among the more intelligent of our farmers, mainly, however, in respect to what we now know of the relationship between the soil, the plant and the animal. The farmer has been taught that the soil is potentially fertile, in proportion to the amount of nitrogen, phosphorus and potassium that it contains; that the removal of crops, resulting in the carrying away of these essential elements, will ultimately exhaust his soil to such an extent as to make their further growth unprofitable, without the addition of the other elements. He has, also, learned from the chemist that a judicious utilization of crops upon the farm, and a careful handling and use of waste products, will extend the period of profitable cropping. The chemists of the country have, also, rendered incalculable service in the study of those substances which carry these elements of fertility, and which are capable of serving as food for plants, and thus developing in a remarkable degree the farmer's ability to use them in the manufacture of crops, in the sense that they may be converted into products of high commercial value. The chemists have, also, promoted the intelligent purchase and use of commercial fertilizers, by the development and improvement of methods of chemical analysis, which enable them to accurately determine the various chemical forms. They have, also, by means of field experiments, demonstrated their comparative influence in meeting soil and crop requirements, and are thus able to give safe advice as to the value of the various supplies.

Still, with all this, and with the utilization of the products in the best manner, we are confronted with the fact that we have but little more definite knowledge of the soil and the principles involved in its treatment than we had sixty years ago. Fertility is not nitrogen, phosphorus and potassium alone, though the potential value of any field, or state or country, from the agricultural standpoint, is measured by these constituent elements in its soil, yet it has been demonstrated that soils which contain an abundance of these elements, and which are potentially capable of producing crops for centuries perhaps, are not capable of producing profitable crops without the addition of further amounts of these constituents. The chemical investigator is, therefore, obliged to take into consideration other facts than this. He must, if he would cover the whole field, know something of geology, of botany, of physics, of biology, of bacteriology and of the other natural sciences, because chemistry alone is not capable of fully compassing the problem, thus the opportunity for specializing in any branch has been very great, and it is because of the broadness of the subject, and the opportunity, as already pointed out, and the necessity,

also, for giving immediate help from the knowledge that we have that has prevented in a degree a broad study of the fundamentals essential for enabling genuine progress to be made.

What are, therefore, some of the questions that now confront us, as chemists, and the solutions of which have so important a bearing upon the agricultural progress, and consequent true development and utilization of our resources? One of the first questions which, it seems to me, is important, is the question of the ultimate effect of the continued use of commercial fertilizers. The problem is before us now. Frequently, questions come which we can not answer. For example, the farmer who has used large quantities of commercial fertilizers for the growing of early potatoes, cabbage, celery, or any other crop of this class, states that his crops do not seem to respond to these applications in the same degree as formerly, and that increasing quantities are required to secure profitable results, notwithstanding calculations show a great accumulation of these elements in the soil. Furthermore, he has, also, learned that other crops in the rotation do not thrive as well as formerly. He can distinguish no marked difference in the character of his soil, but clover, alfalfa, beans or peas, do not grow as well as formerly. He is unable by a judicious seeding of crops, for supplying vegetable matter, to secure a normal and healthy growth. Hence, questions as to the cause of the trouble are asked of the chemist, but can not be answered fully by him. He is unable to point out the cause of the difficulty; he may suggest that the result is due to changes in the physical character of the soil, due to the undue removal of one or more element, not included in the commercial fertilizers applied; to the destruction of certain forms of bacteria, or to the development of plant poisons in the soil, but he has nothing definite to offer. Hence, it seems to me that this is an important problem for our chemists to solve, and which must be solved if we are to make progress, and to give to the farmer what he is justly entitled to, for have we not advised him, by our teachings, to follow the methods which he is now using, without warning as to the possible effect of his work? This condition of affairs applies more particularly to those sections of our country where the lands were not originally abundantly supplied with the essential elements. The areas now requiring large applications of commercial fertilizers are fortunately limited in this rich country of ours, yet they are so located in reference to markets as to make them increasingly valuable. In the richer sections, too, farmers are learning, by sad experience, that the productivity of their soils is not as great as formerly; they know now that their methods of farming have been wasteful, and that the available constituents have, in large part, been removed, yet they have been taught by the chemists that there exists in their soils such an abundance of the minerals as to make it possible to grow maximum crops for centuries, though they are unable, with the knowledge now available to them, to obtain as large crops as formerly, without the application of fertilizers. These areas are so large, that it is manifestly impossible, with the supplies of material in sight, to provide artificial fertilizers, in order to meet the situation; neither is such a practise warranted, with the vast quantities now present in the surface and subsoils. The chemist advises that it is probably a question of imperfect chemical, or physical, or bacteriological conditions of the soil, or of all these combined. The chemist should not deal in probabilities; he

should be able to give positive advice. Hence, this is a problem for the chemist, and one worthy of his best thought—he must find out what the cause of apparent exhaustion is, and he should be able to show the farmer what his sources of loss are and be able to suggest a remedy. It has been shown by many experiments that in the ordinary and common methods of farm practise, there is a loss of the important element nitrogen, from the soil, greater than that accounted for by the removal of crops, and, furthermore, that the judicious application of commercial fertilizer or of yard manures does not result in proportionately increasing, or even maintaining the content of nitrogen in such soils. The chemist, with his present knowledge, advises that the loss may be due to either of three causes, or of one or more combined, viz., percolation into the drains, oxidation, or denitrification, but they are unable to suggest a method of practise which will remove the cause of loss. This is a problem of the first importance, the solution of which must rest with the chemist.

It is true that one phase of the nitrogen problem has been solved, but it has reference to the possible gain of nitrogen to soils, and thus in a sense compensates for the losses, though it makes the question of losses none the less important. I have reference, now, to discoveries that have been made, in regard to the symbiotic action of certain bacteria, which give to the leguminous plants their power of absorbing nitrogen from the air, and dispose of the question, in the sense that so long as the farmer judiciously uses any one of this class of crops in his rotation, it will be possible for him to, not only maintain, but to even increase the nitrogen content of his soils, and thus make the question of exhaustion from that standpoint one not to be feared. It seems to me, however, that we have but reached the threshold in these investigations, for while as a matter of fact such a practise will result in adding this important element to the soil, it does not dispose of the question of the full utilization of the nitrogen acquired. We have many instances of attempts made to improve soils, or to maintain their fertility by the introduction of leguminous crops, which have proved disastrous, rather than helpful, in promoting plant growth, or of permanently increasing fertility in this respect. Furthermore, we have no definite knowledge as yet, as to the conditions which are necessary in order that the plants shall appropriate nitrogen from the air, rather than from the soil, nor have we any definite information as to how large a proportion of the nitrogen so gathered is retained in the soil for the use of cereal and other crops which depend entirely upon soil sources for their nitrogen. I feel certain that no agricultural chemist of the present day would dare to risk his reputation on a positive statement, in reference to any one of these phases of the question. The nitrogen question in agriculture is far-reaching in its influence, affecting not only those who cultivate the soil, but those who depend upon its products for their sustenance and profit; it is a question which has occupied the student of chemistry from the earliest times, and the various theories advanced have caused no end of controversy among them, yet in many of its phases it is still a problem to be solved.

Another question, closely associated with this one of nitrogen, if not intimately connected therewith, is that of the importance of humus in relation to fertility. It has been recently stated by an eminent experiment station director that 'the mineral elements form but the skeleton of the

soil, and without humus, which gives life and activity are practically useless as a medium for plant growth.' This statement is an attractive one, and may be in a broad sense correct, but, notwithstanding all of the investigations that have been made, I am of the opinion that much has yet to be learned as to the function of humus and the influence it exerts in the maintaining and improving of the fertility of our soils. We are unable from our present knowledge to state whether the effect is physical, chemical or biological, or whether it is a combined effect of each, or whether it is absolutely essential that the organic matter be present in large amounts, in order that the best results may be obtained. It is a problem well worthy of the attention of our agricultural chemists, and one which must be solved, if we are to give safe advice as to the cultivation of our soils.

Still another problem, which is agitating the minds of many far-seeing investigators, is the question of the supplies of artificial plant-food, aside from that involved in the question of nitrogen. As already pointed out, it has been clearly demonstrated that so far as the mineral elements are concerned, there is sufficient in the soils of this country to supply the needs of maximum crops for centuries, but this statement must be modified, so as to read 'sufficient to supply the needs of general crops, cereals and grasses, or any other crop which in its cultivation is allowed to develop under natural conditions,' but it does not apply to that class of crops, the need of which is increasing rapidly, that can not be grown to perfection in such quantities as to meet the demands of a modern civilization, without the stimulating effect of immediately available plant-food. I now refer to the large number of vegetable crops, fruits, berries, etc., which must be produced under semi-artificial conditions, in order that they may possess those characteristics of quality, and be provided at such times as the present demands require. There will, therefore, be a constantly increasing demand for plant-food, which can not be supplied by natural means, including the use of home-made manures.

The nitrogen question, as already pointed out, has received the attention of eminent investigators, and the problem has been solved in so far as the actual obtaining of free nitrogen from atmospheric sources, both by means of special classes of crops and by chemical combination. How soon the latter may be a practical source is still a question, but the progress thus far made indicates that the solution will be reached in the near future. There is, however, still a broad field for study, as to the source of supply of phosphates and of potash salts. We have in this country, and in Canada, enormous deposits of phosphate rock, already exploited; others will undoubtedly be found, so that the question is not one that requires such immediate attention. Nevertheless, with the great demands which are likely to be made, it is one well worthy of the study of our chemists. In the case of potash, we have no source of supply, at present, other than the Stassfurt mines of Germany, and the time must come, sooner or later, when these will not be able to meet the demand. Whether the potash stored in our granite hills are to supply these demands, or whether unknown deposits exist in our country, are questions that must occupy the minds of our agricultural chemists, and are problems which are of fundamental importance, because they have to do, not only with the production of crops, but with the future progress of humanity.

Still another question, or problem, which it seems to me the chemist should solve,

is rather of economic importance than of pure science, since it has to do with the transfer of the plant-food elements from one place to another, and their loss, in so far as our own country is concerned. It is a problem which has been but lightly touched upon, though many have recognized its significance. We are exporting in whole grains, and in waste materials from our oil and starch factories, enormous quantities of human and animal foods, for which we receive a return only in proportion to nutritive values, whereas these products carry enormous quantities of constituents from our country. The problem here, as already stated, is not a problem so much of investigation as it is an exploitation of the facts, and the education of the people as to the possible ultimate effect. The agricultural chemist must stand as the conservator of the nation's wealth; he is the one whom others seek for definite information, and for guidance, and it is his business to so direct the attention of the people as to prevent an undue loss of our fertility elements.

There is no doubt but that by careful adjustments of trade conditions it will be possible to obtain quite as much money for our surplus products as is obtained at the present time, without having the practise result in so great an annual loss of our plant-food constituents. The problem is not an easy one to solve, though I am sure that with the earnest study and support of our agricultural chemists, it will be solved in a manner that will result in the best good to all. It is an important question, and one which I hope our chemists will regard as worthy of their study.

I am well aware that in this brief paper, which was purposely made general in its character, I have done little more than to point out some of the reasons why the conditions have not been favorable thus far for such work as seems now to be needed, and to suggest lines of investigation, without being specific as to the methods by which they should be carried out. Nevertheless, the few facts stated are patent to all who have given the subject thought, and are sufficient to indicate the importance of a broad and detailed study of the whole question of soil fertility. The field is now largely unoccupied, and there is a growing demand for broadly trained investigators, and there is no field of investigation more promising of fruitful results for the investigator and the country at large. Our professors of chemistry and our colleges and universities should cooperate in providing such opportunities for study as shall fit them to pursue this attractive and important line of investigation.

E. B. Voorhees.

New Jersey Agricultural Experiment Station.

THE TEACHING OF SCIENCE IN COLLEGE.[1]

I wish to call attention to a situation which seems to me unnatural and unfortunate. It is unnecessary to present it in statistical form. No one will question that science in the colleges of this and other universities has not the importance and popularity that it should have, that this element of our modern education is by no means represented in the results of education in accordance with its importance.

It is not, however, to the failure to elect scientific courses as they are to-day or to enroll themselves for science degrees on the part of our students that I think especial attention should be directed. Nor do I think that we can explain this and other evidences of the deficiencies in this regard by the traditional prestige of the so-called humanities, or the prejudicing of the stu-

[1] Address delivered before the Chicago Chapter Sigma Chi, March, 1906.

dents' minds by preparatory courses inimical to scientific interest.

Scientific courses have not become popular as the old requirements in the languages have been decreased. It is rather the other courses such as the Ph.B. that have profited by the greater freedom of election. With considerable freedom of election in the preparatory schools the scientific courses are not sought out there by the children at a period when the concrete subject-matter of science properly presented should be immensely more attractive than the languages and many more abstract objects of study. The science courses in the high school are not at the present time popular, nor is the money spent upon them, either in equipment or in teaching force, comparable with their educational importance.

The result of this is that the majority of our students leave our colleges and universities, without being able to grasp the most important achievements in modern thought, without being able to take the point of view of those thinkers who are reconstructing our views of the physical universe and its constituent parts, and without being able to interpret what they see and hear and feel by means of the profoundest and most magnificent generalizations which the world has ever known.

I wish to present two reasons for this condition which seem to me more fundamental than those usually presented, and to discuss in connection with them the possibility of removing them or at least to invite discussion on the subject.

It is natural to compare the sciences so-called with the humanities. And yet in one respect the distinction between them has much decreased of late years and promises to continue to decrease. The method of study of the languages, history, literature and the so-called social sciences has become to a large degree that of the natural sciences. There is certainly no fundamental distinction between the researches of the historian, the philologist, the social statistician and those of the biologist, the geologist or even the physicist and chemist, in point of method. Each is approaching problems which must be solved, and to be solved must be presented in the form of carefully gathered data. For their solution hypotheses must be constructed and tested by means of experiment or observation. With the complexity of the phenomena, of course, the application of the scientific methods will vary. The processes of observation, for example, will vary enormously in the study of a historical problem in the ancient world, and in the study of the problem of variation where the material is immediately at hand. The methods of historical criticism—lower and higher—are nothing but methods of observations under conditions which are peculiarly difficult of access.

While it is true that in literature and other arts we do not go back of the esthetic reaction in the judgment of beauty, or the study of this reaction in others as presented in literary criticism; outside this field of appreciation and criticism, the methods of study in the field of the humanities is just as scientific as the subject matter with which it deals allows.

This means for one thing that we no longer regard the acquirement of information as the legitimate object or method of education. The ideal of modern education is the solution of problems, the research method. And this research method is no less dominant in the humanities than it is in the natural sciences so far as the subject matter permits.

The ground for the difference in attractive power of the natural sciences and the humanities can not be laid up, therefore, to a difference in method. And if it could the prospect would be discouraging indeed

and the judgment upon the students most unflattering, for the research method is, after all, nothing but the elaboration of the simple processes of perceiving and conceiving the world, elaborated in such a way that it can be applied to the complex and subtle problems of the physicist, the geologist, the biologist, etc. If the scientific method were the cause of unpopularity we should have to assume that the process of knowledge itself, the very function of cognition, was disagreeable to the average student.

If, however, we examine these two types of studies we do meet a distinction which holds for many if not for all. In the physical sciences the process of investigation involves the analysis of the objects, which are studied, into elements which are not present to immediate experience and which are with difficulty conceived and presented to the mind. The resolution of nature into atoms and molecules or corpuscles is an undertaking presenting itself at the beginning of scientific investigation, that is not forced upon the social sciences. Here the elements into which analysis reduces its objects are at bottom, but more or less reproducible states of our own consciousness, or still more direct objects of possible sense-perception. This was a difficulty that did not inhere in the old-time natural history. There the problem that aroused investigation was stated in terms of everyday experience, and for this very reason natural history was a more successful subject in the curriculum than our physics and chemistry. Its problems were real problems in the minds of the students. They were not located in a field as yet foreign to their acquaintance and, therefore, artificial and unmeaning.

The problems of biology and geology do not suffer as much from this remoteness, for to a large degree they can be stated in terms of a possible immediate experience of the student, and it is true that they make a more immediate appeal to the student than do the physical sciences. But it must not be forgotten that these biological and geological sciences are to no small degree applied physics and chemistry, and that this tendency is steadily increasing. That is, it is increasingly difficult to state the problems of these sciences in terms of immediate experience; their problems do not arise of themselves in the consciousness of the student, in other words, he is not immediately interested in the study.

We can generalize this in the following form: the result of the development of our sciences has been that their problems are no longer within the immediate experience of the student, nor are they always statable in terms of that experience. He has to be introduced to the science before he can reach the source of interest, *i. e.*, problems which are his own and which he wants to solve by the process of his own thinking.

On the whole, the problems of the social sciences have a meaning to the student when he meets them, *i. e.*, they can be his own problems from the start, and they do not have to be translated into terms which must be somewhat painfully acquired before they can be used.

In a certain sense mathematics has become the language of the physical sciences, and the student must have a command of this vernacular before he can read with interest that which is writ in the sciences, before he can attack their problems. But even where the vernacular of the science is not that of mathematics, it is still true, to a large extent, that the field of the real problems in the science lies outside of the direct experience of the student.

It hangs together with this, in the second place, that the natural sciences are not interconnected in the minds of the students, that they exist in water-tight compartments. There is no common field out of which they all spring. It seems to me that

in this lies the great advantage which the humanities so-called have over the natural sciences in the curriculum. They all of them belong to one piece of human experience, and it remains true *nil humanum mihi alienum est,* not simply because of the immediate human sympathy which unites men and women who are distant not only in space, but also in time, not only in speech, but also in state of civilization; there is a still more important hold which the social sciences and humanities have upon the interest of the student. It is that human history, human development, human institutions, its arts, its literature, its achievements, are so bound up together with each other, with the languages in which thought has been expressed, with the literature in which achievements have been recorded, with the movements of trade, commerce, colonization and discovery which have motived historic changes, that wherever one begins, problems of all sorts arise at once, interlacing with each other, so that the pursuit of one subject reinforces the interest in another, and *vice versa.* The whole group represents one social world which can not be picked up piecemeal nor divided up into separate compartments, but is bound to exist in the mind as a whole.

This is not simply an advantage of an external sort. The logician tells us that, if we would expand it, the subject of every judgment would be found to be the universe itself, individualized in some immediate experience, but implying the whole world in its implicit relations. If we express this somewhat more modestly it would run, in educational terms, that it is only the implicit relation to other things that makes any subject teachable or learnable, and that the more evident and more pregnant these relations are the more readily is it assimilated. In a certain sense the more complex a thing is the more readily it is acquired, while its simplicity leaves it bare, without lines of connection, without retaining points. Of course this would not be the case if education were merely a process of storing away, a process of piling learning into the mind. But as the theory of science instruction, as well as scientific advance, is that of research, it is evident that the richer an object is in relation to other things the more suggestive it will be of solutions for problems, the more fertile it will be in arousing associations of kindred data. To bring out a problem then in a field which is already rich in interest is to insure not only its immediate attractiveness, but to provide the ideas and connections through which the problem may be studied and a solution reached.

It is this wealth of associations, this complex interrelation with a mass of other things, which the student fails to secure when he is introduced to modern science, through one door at a time, and that door leading into a specialized subject-matter whose relations with immediate experience are of the slightest character. A new subject should not be presented by itself, but in its relation to other things. It must grow in some fashion out of the student's present world.

The problem of college science is, therefore, very intimately connected with science in the secondary school. If the child were introduced to it in the proper way there the situation, which has just been described, would not exist in the college. He would come up into the college with the world of science already in existence, and that world as a field of his own experience. He would find problems arising there for whose solution he must look to the more specialized sciences. But the opposite of this is the case. Science in the high school, at the present time, is in a more parlous condition than it is in the college, because the child is farther away from the field of exact science

than in the later college years. He finds fewer points of connection. His sciences remain for him located between impassable barriers. The college, therefore, at least until a reform can be wrought in the secondary school, is forced to face the problem within its own walls.

Its solution calls for introductory courses which will lead the student into the field of science, which will show the problems of his own experience in terms of this new field, and show them there capable of solution. There are two points of view from which such courses could be naturally presented; that of history, and that of a survey of the world analogous to what is given in introductory courses in sociology or social institutions.

The peculiar appropriateness of a course in the history of science for the junior college students, lies in the fact that the special character of modern science would grow out of the conditions that made it natural and necessary. There would be in it the inspiration of the personalities of the great scientific men, and the romance of their struggle with difficulties which beset their sciences from within and without. The conceptions of to-day would be found motived in the struggles of yesterday. But still more important the relations which have subsisted between scientific investigation and the whole field of human endeavor would appear—its relation to commerce, industry, the geographical distribution of men, their interconnection with each other, and the other sides of their intellectual life. Science would be interwoven with the whole human world of which it is actually a part. It is true that something of this is found in general history. It is there, however, presented not to lead up to further study of science, but to merely fill out the entire picture—a picture which is so crowded that many features are bound to be slighted, and among those which are slighted, science, just because it is a subject somewhat apart, is sure to be found.

We have of course the evidence of the import which such a course would have in the biographies of our scientific men—such as Darwin, Huxley, Pasteur, von Helmholtz. But few of our students in that period read them, and taken by themselves they do not have the educative power which the story of their efforts would have when presented in a course on the history of science. It is not, however, principally the personal note, which comes from the account of the men who have been the heroes of science, that would be found in such study. It is rather the form in which the scientific problem arose and the methods used for its solution which will carry the most valuable instruction. One scientific theory swallows up into itself what has preceded it, and the traces of the situation out of which the later doctrine arose are washed away. While our historical atlases present us in flaring colors the political situations out of which sprang present political conformations, the young student of science must pick up, as best he may, without assistance or interpretation, the explanation and historical interpretation of the conceptions he is forced to use. If an adequate comprehension of the powers of the American executive can not be gained without a knowledge of the situation which preceded the formation of the constitution, no more can the uninstructed student comprehend the value of such terms as forces, energies, variations, atoms or molecules without understanding what the problems were which brought forth these hypotheses and scientific conceptions.

And there is no study like that of history to bring out the solidarity of human thought. The interdependence of scientific effort and achievement, and the interrelationship which exists between all science in presenting its world as a whole, can be

brought out vividly only when its history is being presented, while in the midst of the arduous struggle with a single science these profound connections are quite overlooked. It is a fact that science is, from an important point of view, a single body of knowledge, whose different parts determine each other mutually, though this mutual influence is often overlooked. When the historian comes forward with the picture of a past age, such as Gompertz has given us in his 'Grieschische Denker,' we recognize these interconnections and see that what has been done in one line has been now advanced because of the achievement of another, and now has been thwarted by the backwardness in still another. The Weltanshauung of any age is at once the result of all its scientific achievements and a cause of each, by itself. We can not finally understand any one without the comprehension of the whole, and it is the whole which is more comprehensible than any single science. It is a great deal easier to present the problem of evolution in the world as a whole than it is in the specific instance. It is easier to recognize the problem of matter, as it is presented in the book entitled ' The New Knowledge,' than it is to present the specific problem with which the physicist or chemist must wrestle. It may be a Hegelism, but it is good educational doctrine that the whole is more concrete than the part. A student who has first followed out the results of scientific evolution through the preceding centuries in their interconnection with each other, and meets then the problems of modern science as the growing points of the past, who understands somewhat what the controlling meanings are behind scientific concepts and terminology, who feels that he is entering into a battle that is going on, whose field he has surveyed before he has lost himself in the particular brigade, such a student is bound to enter into his study with both a comprehension and an interest which his brother will lack —his brother who must get the parts before he can have an inkling of the whole.

I am aware that, in the minds of a great many of you, there has arisen a spirit of contradiction to what has been presented, a spirit of contradiction which arises out of the very competency and exactness of the scientist. Such a type of instruction as that suggested above is felt to be superficial, inexact, and bound to be misleading to the person who is not scientifically trained. It would be information in a word, and the scientist does not hold it to be his position to impart information, nor can he promise any valuable educational result from a course whose content is one of information.

I wish to bring out the point because it seems to me fundamental to the question which has been broached. We need, in the first place, a definition of what information is and what knowledge is, as distinguished from it. I would suggest toward such a definition that nothing is information which helps any one to understand better a question he is trying to answer, a problem he is trying to solve. Whatever bridges over a gap in a student's mind, enabling him to present concretely what otherwise would have been an abstract symbol, is knowledge and not mere information. Whatever is stored up, without immediate need, for some later occasion, for display or to pass examinations is mere information, and has no enduring place in the mind. From this standpoint nothing is superficial or inexact which gives concreteness and meaning to the problem before the student. Truth is a relative thing. We none of us have exact knowledge in the sense that our knowledge is exhaustive, and we none of us know the full import of what we do grasp. There can be no objection to the young student having a broad if seemingly superficial view of the scientific world, if it helps him to approach with

more understanding the particular science he has before him. It is also certainly the pedagogic duty of the instructor in science to get far enough into the consciousness of the student to present the part to him by means of the whole.

The second point of view suggested for approach to the specialized study of science was that of the survey of the present field. If we can find the counterparts of the historical course in the biographies of great scientists, we can find that of the survey course in such treatises as the popular lectures of eminent scientists, such as those of Tyndall on 'Sound,' or many of the popular lectures of men like von Helmholtz, du Bois Reymond and a score of others. We highly approve of such lectures when they appear on the lyceum or the university extension platform. We encourage the reading of such books, considering them distinctly educative, but we deny that they have a place in the university curriculum. The prevailing assumption is that when one can not follow out the scientific process by which the results are reached, it is indeed better that he should have the result presented in a form which he can understand than not to have them at all, though it is not the place of the university to perform this function, except through its extension department. This statement, however, overlooks the fact that such acquaintance with the results of scientific research is also the source of interest in the research itself. What is merely keeping up with the progress of the world on the part of the business man is preparation for the student who has to approach a new field. I presume that no one would question that those who had listened with intense interest and enthusiasm to an extension lecture upon the solar system would be better prepared for the study of astronomy. Indeed, we assume that university extension will serve in this fashion as a feeder of the university, but for some reason we feel that this same sort of preparatory work has no place inside of the university itself. From the point of view of education we are mistaken, for nothing is out of place which makes the approach of the students to the subject-matter a normal one. And until the student feels the problem of the science he undertakes to be a problem of his own, springing out of his own thought and experience, his approach is not a normal one.

One or two courses, then, from the standpoint of the history of science, and from that of the survey of the scientific field of to-day in the junior college, would organize the vague information of the student, would correlate it with the political and literary history with which he is familiar, would give him the sense of growth and vitality, would state the problems of science in his own terms, and awaken in him the passion to carry on the investigation himself which might otherwise remain dormant. They would be feeders to the specialized scientific courses that follow. They would break down the prejudice which most students bring against science from the high school. But not least, they would be as educative as any course in history could possibly be. They would serve as valuable a function as those courses which aim to acquaint the student with the social and political forces which dominate the world into which he is to enter.

What has been said so far has borne directly upon introductory courses in the junior college. It is only in the last remark that I have touched upon the demands which the university may make upon its scientists for the interpretation of the world for those who do not follow its special courses. If in the present day, under the sign of science in nature and society, any one leaves an institution of higher learning without a comprehension of the results of science, which he can grasp

in their relationship to the rest of human history and endeavor, he is certainly cheated out of one of the most valuable of the endowments which he has a right to demand from that institution. As I have already indicated, scientific method is dominant not only in the study of nature, but in the study of all the social subject-matters, in religion, politics, in all social institutions. Scientific discoveries have made over the answer even to the fundamental question of who is my neighbor. Science is responsible for the view of the universe as a whole which must be the background of our theology as well as our philosophy and much that is finest in our literature. Science has changed sentiment to intelligence in divine charity, and has substituted the virtue of reformation of evil for that of resignation thereto in religion. And yet a large percentage of our students leave the university without having any better opportunity of coming to close quarters with this science than those who are outside the university. They are compelled to get their science from the extension platform, or from the popular magazine. There should be unspecialized science for those who do not specialize in science, because they have the right to demand it of an educational institution.

There is still another demand that should be made upon the science faculties of the university, and that is that they should so organize the courses which their students take, that they will get the unity which every college course ought to give.

That unity of the social sciences which is given in subject-matter and human nature itself, is, as has been pointed out, absent from modern sciences which have become largely what Professor Wundt calls conceptual sciences. The interconnections are not apparent to the students who are in the special groups. Their attention is fixed within too narrow boundaries, the demands of their own subject is so great that they have no time to go beyond. They have a wealth which they can not realize because they can not put it into circulation.

Through the history of science, especially of the other sciences which they do not specialize in, through lecture courses which give them the results of these other sciences they should be able to get the unity of Weltanschauung, which is requisite for any college course.

It is requisite at the end as at the beginning that the student should see his world as a whole, should take up into it what he has acquired, and should get the mutual interpretation which the relation of his subject-matter has to what lies beyond it.

There is certainly no agent that can carry more profound culture than the sciences, but our science curriculum is poor in what may be called culture courses in the sciences, and the import of science for culture has been but slightly recognized and but parsimoniously fostered.

GEORGE H. MEAD.

SCIENTIFIC BOOKS.

An Introduction to Astronomy. By FOREST RAY MOULTON, Ph.D., Assistant Professor of Astronomy in the University of Chicago. New York, The Macmillan Co. 1906. 8vo. Pp. xiii + 557; 201 figures, including 50 photographic illustrations. $1.25.

This book is an elementary, descriptive text, suited to those who are approaching the subject for the first time, and from this point of view the selection of material is quite satisfactory, though not always presented in logical order. At the outset Professor Moulton gives a preliminary outline of the entire subject, followed by chapters which treat in greater detail of the topics usually considered in elementary works, such as systems of coordinates, the constellations, the classes and uses of astronomical instruments, and the leading facts and theories relating to the various bodies composing the solar and sidereal systems.

The book is designed to be readable even by those without extensive mathematical or scientific training; to give a general view of the results that astronomers have obtained in the course of their investigations; and to reveal something of that spirit which inspires scientific work. Astronomers to-day, perhaps more than ever before are endeavoring to solve great problems. The investigations leading to these ends are diverse, extended and many-sided, and the data drawn from the various sources often admit of widely different interpretations. In some departments advance comes from adhering to the hard and fast facts derived from exact measurements, in others from speculative inquiries based upon data that are more or less insecure, founded upon such observations as have been made to the present time. Often contradictory working hypotheses lie so near the limits of indetermination that one is as plausible as the other, and this is so in many of the problems of great human interest as they stand to-day. Hence it is not always easy to decide between rival hypotheses, for the overbalancing data favorable to one to-day may by fresh accessions to knowledge be turned to-morrow in favor of the other. In producing a work on astronomy for the general reader, and for the student as well, some attempt should be made to give that broadening view that the subject affords, not only by reason of its established facts but from the outlook afforded by investigations now in progress. The latter requires the inclusion of outlines of various theories still in formation, to be accepted or rejected according to the evidence that may be adduced in favor of or against them. In his 'Introduction to Astronomy,' Professor Moulton has many references to unsettled questions. He has always considered them with caution, giving briefly the arguments on both sides of debatable points, without commending to the reader one view rather than the other. The chapter on the evolution of the solar system, which may be regarded as the distinctive one of the book, deserves special mention, since it deals largely with the arguments tending to prove the general insufficiency of the Laplacian ring nebular hypothesis, which has so long held a place in elementary texts, and to the exposition of the new spiral nebular theory developed by Professors Chamberlain and Moulton. Even in reference to the latter the author cautions the reader against the too hasty acceptance of it as final, for much still remains to be accomplished in the way of quantitative determinations before this theory can take its place among the accepted results of science.

W. J. Hussey.

Ann Arbor, Michigan.

Introduction to General Inorganic Chemistry. By Alexander Smith. 8vo, pp. xviii + 780. New York, The Century Co. 1906.

This unusually excellent text-book is intended primarily for beginners in college courses. The author has wisely made the elucidation of chemical theory the main feature of the book, but the descriptive part has been well chosen for the purpose in view. Laboratory experiments are used as the basis of treatment, and the theories are thus explained in a very clear and satisfactory way. The subject is treated from the most modern standpoint, but this has been done without giving undue prominence to the newer theories.

An important feature of the book is found in the numerous references to previous pages, which enable the reader to refresh his memory in regard to matters already discussed. Other points attracting attention are a diagram showing the solubility curves of eighteen important salts, a table showing the actual and molar solubilities at 18° of more than a hundred salts, the use of the single or double arrow in place of the usual sign of equality in chemical equations, the introduction of many suggestive exercises or questions for students, and a serviceable index.

The course here presented is undoubtedly a long and difficult one for the average student, who relies mostly upon memory and possesses little or no power of reasoning; for it comprises practically the whole body of modern chemical theory, which is not grasped easily by the chemically vacant mind. However,

Professor Smith's work is certainly a good book for good students, and as such is to be heartily welcomed. H. L. WELLS.

SCIENTIFIC JOURNALS AND ARTICLES.

The Botanical Gazette for August contains the following papers: 'The Nascent Forest of the Miscou Beach Plain,' by W. F. Ganong, being the fourth contribution to the ecological plant geography of the province of New Brunswick; 'The Development and Anatomy of Sarracenia,' by Forrest Shreve; 'Physiologically Balanced Solutions for Plants,' by W. J. V. Osterhout; 'The Appressoria of the Anthracnoses,' by Heinrich Hasselbring; '*Nereocystis Luetkeana*,' by Theodore C. Frye, being a biological study of this giant kelp; 'New Species of Castilleja and Senecio,' by J. M. Greenman. The September number contains the following papers: 'Differentiation of Sex in Thallus Gametophytes and Sporophytes,' by A. F. Blakeslee, being a general discussion of sexuality in all the plant groups; 'The Development of the Bouteloua Formation,' by H. L. Shantz, being the second contribution from his study of the mesa region east of Pike's Peak; '*Cortinarius* a Mycorhiza-producing Fungus,' by C. H. Kaufmann, in which a new species of the genus is described that is connected with three forest symbionts belonging to different families; 'A New Fungus of Economic Importance,' by R. E. Smith and Elizabeth H. Smith, being a new genus (*Pythiacystis*) parasitic on lemons and causing a decay of green fruit trees and in the storehouse.

DISCUSSION AND CORRESPONDENCE.

DISCONTINUOUS VARIATION AND PEDIGREE CULTURE.

REFERRING to the recent address of Dr. D. T. MacDougal, on 'Discontinuous Variation and Pedigree Culture' (published in *The Popular Science Monthly* for September), the following points may be worth considering:

The species is the unit of the taxonomist, and the study of species and their relations to environment form the basis of the science of distribution.

The species, as thus considered, is a kind of animal or plant as it has developed and as it appears in a state of nature. To know a species as it appears is not to know it completely, as all species develop differently under changed conditions or freed from the stress of competition. Under domestication, or under new chemical or physical conditions, all species are plastic, and all may assume forms the same species can never assume in its original habitat.

The field naturalist can not therefore know everything about any species, no matter how many individuals he may examine. Neither can a garden naturalist, for the forms he deals with must be 'reduced to the ranks' before they are comparable to the species occurring in the wild.

It is presumable that those naturalists know most about species as they are, who have given most time and thought to their study. They may not, however, know better than any others how species originate, nor possess the clue to the main causes or significance of their varying forms.

Yet it is fair to say that as the taxonomist of species finds in practically every case a geographical element in the development; as he finds that segregation and selection have apparently been accompaniments of nearly all changes in species, and as by these same agencies all species can be appreciably changed by the will of man, he may not unreasonably suppose that segregation and selection have each taken some part in that life-adaptation which we call organic evolution.

As a zoologist personally acquainted with Dr. de Vries the writer has great reverence for the noble modesty, the patient, intelligent and epoch-making perseverance which have characterized his work. On the other hand, he is obliged to hesitate at the acceptance of the more sweeping parts of his theory, and to question the assumption that the discoveries of de Vries in plant mutation disclose the actual method of species-forming, general or universal, in all branches of life.

As matters are the species that exist in nature must furnish us our conception of species. The species actually covering the earth are

surely 'real' species, whether other forms called species are 'real' or not. We find no evidence that such species could not or do not originate, sometimes at least, through slight fluctuations acted upon by selection in segregation. We do not know that the effects of selection have any final limit except in certain cases where the limit is mechanical. It is not yet clearly shown that there is any real and fundamental difference between continuous and discontinuous variation, and most zoologists regard the conception and cycles of variation in the history of a species as an ingenious suggestion rather than as a part of science.

It is evident that there is much—very much—about animals and plants, which can be learned only from experimentation under changed conditions, as there is much that can not be known or even imagined without the aid of the microscope, and much that can not be known or imagined without the comparative study of many individuals and the comparison of faunal and floral areas. We must welcome the study of pedigreed individuals, animals or plants, as a most hopeful line of investigation, and it is certain that the discoveries it may yield can not be forestalled in advance. If they could the investigation would be unnecessary. So far as species are concerned, it is clear that a large part of the problem demands the study of the structure of forms and their relation to environment. There is much truth in Darwin's words that "One has hardly a right to examine the question of species who has not minutely described many."

As to the suggestion of the possible hybrid origin of Œnothera, the writer is not a botanist, and very much of botanical investigation escapes his notice. He is pleased to learn that the possibility of such origin on the part of *Œnothera lamarckiana* has been considered and fully disproved. A detailed account of the experiments which show this would be interesting. It would also be interesting to know the degree in which Burbank's hybrid walnuts of the second generation, showing 'every conceivable kind of variation,' conform to the Mendelian theory.

As to the theory that species are permanently changed by the direct impact of environment, which most faunal zoologists in America seem to accept, the writer thinks that Dr. MacDougal is probably right in claiming that "no evidence has yet been obtained to prove that the influence of tillage, cultivation or the mere pressure of environmental factors has produced any permanent changes in hereditary characters of unified strains of plants," or of animals either.

David Starr Jordan.

VULCANISM.

I have read the article of Elihu Thomson,[1] much of which is necessarily true, with considerable interest; but I doubt whether I can go so far as he does, partly because I have a pet theory of my own to nurture. What I miss in Thomson's article is some definite estimate or clear-cut specification of the actual conditions involved: how much stuff is moved; what work is spent; how much heat is generated. I have endeavored to picture the occurrences to myself in a cursory way for a normal case, somewhat as follows: The work done per cubic centimeter will in any distortion be half the product of the stress and the strain. This work will be elastically potentialized if the solid remains intact. If there is rupture it will appear as heat largely near the surface of separation. If it yields viscously (as is much the more probable) it will appear throughout the volume. The strain is probably a shear. The question at issue is then under what circumstances of torment must one shear a rock in order to melt it. Suppose we say the shear is one half, *i. e.*, if the tangential thrust is horizontal all initially vertical lines will be inclined thirty degrees; or in general there will be corresponding changes of inclination of thirty degrees, which seems to me to be enormous, but may, nevertheless, be admitted for the purpose of argument. We may then write, if the density of rock is 3, its specific heat .2, its igneous melting point as low as 1,000° C.,

$$\tfrac{1}{2} \times \tfrac{1}{2} \times F = 3 \times .2 \times 1000 \times 42 \times 10^6,$$

[1] Science, XXIV., p. 161, 1906.

to determine the tangential stress at F involved. It follows that $F = 10^{11}$ dynes/cm.^{2} or 10^5 kg./cm.^{2}; or since in a shear the tangential and the normal stresses are equal per square centimeter, about 100,000 atmospheres, even for the excessive strain in question. Now in a region where differential stresses of this value abound, the pressure itself must be at least of the same order, and hence if we compute such pressures hydrostatically (a case most favorable to shallowness of the seat of reaction) with ten feet of rock to the atmosphere, this would be equivalent to a depth below the surface of one million feet or 190 miles, where a shear of the value of one half is surely out of the question. Imagine the earth radii all flexed by this amount at their outer ends. Besides we are much too far down for practical vulcanism. Of course, we can get nearer the surface with bigger strains and smaller stresses, or we may imagine the energy of a fault all spilled upon the surface of rupture; but even in this case while the work done will depend on the volume displaced, it will also in a large measure be dissipated within that volume and by no means on the surface of separation alone.

The picture as a whole is not alluring because it is vague, to me at least, who am all the while fondling my own little notion. In fact I once came as near being a physical geologist as Elihu Thomson, though nobody seems to have found it out. Yet in the days when I still deluded myself into thinking such things interesting I happened upon an astonishing result in the endeavor to dissolve hot glass in hot water.[2] It did in fact dissolve to an eventually solid substance, which for hardness and optical character was not distinguishable superficially from the igneous glass; and it did this completely (in water, not in steam) at a temperature certainly much *below* 200° C. and in such a way (this is the point) that the system of igneous glass and liquid water contracted on combination as much as 20 or 30 per cent. of the initial total volume. Think of this; the contraction of concentrated sulphuric acid upon admixture with water is but 2 to 3 per cent., and even granting that molecular changes and not volume contractions are the truly important features, the case for water-glass can not be so easily dismissed. Whoever has tried to coerce a solid-liquid system (as I did) knows that he has a task on his hands; and whoever tries to diminish bulk 20 or 30 per cent. (which I didn't do) is destined to fall very short of his hopes. I argued, therefore, that the solidification of water in glass, under the exceptional conditions stated could hardly take place without the evolution of heat such as accompanies any solidification of the liquid. All efforts to prove the inference directly miscarried; but in case of a reaction which proceeds very gradually, in small compass and under high pressure, failure is almost a foregone conclusion. Nature, as Elihu Thomson truly states, in her ideal laboratory can garner the heat of a slow process, while such heat slips irrecoverably through our fingers in the workshop. At this point then my argument is based not on direct but on circumstantial evidence, and if I were the reader, and not the writer, I would merely grant a fused glass at a temperature presumably somewhat higher than the melting point.

To me the picture obtainable from the bearing of these experiments on vulcanism is more attractive than any other with which I happen to be acquainted, even if I have to chaffer uncomfortably for the excess of heat above mere fusion which seems to be present, as if my glass had gnawed its way convectively into the higher temperatures of deeper isotherms. The idea[3] here is important: it is probable that the water in a magma at 200° will diffuse into a magma at 300° (and higher in turn), across the surface of contact. The region of fusion is, therefore, essentially *sinking* in character in its avidity for magmas at

[2] *American Journ*, XLVI., p. 110, 1891; VII., p. 1, 1899; IX., p. 161, 1900. *Phil. Mag.*, XLVII., p. 104, 461, 1899.

[3] Inferred because the rate of solution increases rapidly as temperature rises. Moreover the higher temperatures of deeper isotherms are being continually brought from lower to higher levels by convection, as solution proceeds.

higher temperatures. If the supply of water holds out above, the fused region will enlarge downward and laterally until, with excessive size, the rigidity of its confines breaks down.

To keep water liquid at 200° C. it is merely necessary to tap the ocean at a level greater than 500 feet below the surface, while a depth of five miles of water may be available. The 200° isotherm may also be put at a distance of about five miles below the solid surface, but it is correspondingly lifted up on the shores of the ocean. Near the ocean, therefore, this earth level is potentially fused, if by whatever catastrophe the ocean penetrates as far as the 200° isotherm, barring the 3,000 atmospheres of pressure which one may ascribe to the given depth of the isotherm below the surface. In view of the rigidity of rock, such pressures are not yet irresistible, when burdening the solid framework of a region not too large. The effective pressures are smaller. Fusion will depend upon the character of the rock magma found in place; it will be rapid if basic, slow if acid, but will in every case constitute a local source of heat, since as in Thomson's case, the region of reaction is nicely jacketed in a way to guarantee the utmost amount of mischief. More than this; water-glass becomes saturated subject to temperature and pressure, after which the heat reaction ceases, and the chances for vulcanism become extinct. Furthermore, there is a chance for periods. Finally one would expect the region of volcanic activity to correspond in depth with the depth of the ocean; and again to be on the margin of the ocean without being necessarily absent in the interior of continents. Could anything be more cleverly dovetailed? What if the heathen rage and say 'qualitative' or 'inadequate'; what if throughout all the turmoil of the Pelée eruptions, not a soul has thought it worth while to quote my results. I am now doing this myself.

But Elihu Thomson will have none of it. 'No water would enter a hot stratum unless forced in by pressure in excess of that which the steam would acquire upon its generation,' etc. Unfortunately we have to do with much more than a mechanical phenomenon. The chief pressures in question are capillary and osmotic pressures. Steam will pass through porous rock against very considerable pressures.[4] I remember that I once had an occasion to pass a very fine spray of air through water. Nothing seemed simpler: I tried to force the air through a submerged cup of unglazed porcelain. But it would not work! A little consideration showed me afterwards that it takes ten atmospheres to do that, and the wretched old trap blew up before this pressure was reached. Through dry porcelain the air escapes jauntily enough, but it will not do so if the pores are stoppered with water. One may estimate in the same way that pores of molecular dimensions, as in case of osmotic phenomena, and diffusion would call for many thousands of atmospheres if water is to be forced through, so that the pump which feeds the vulcanic boiler to use Thomson's image, is not a cast-iron contrivance. But apart from this, having once fused my glass I am at liberty to putty up every fissure that may interfere with my business. I am quite unwilling to leave Elihu Thomson a single crack to puff away my steam, unless it be the cataclysmal break-up by which my glass, pumiced or not, or any of its ingredients, water and mud, are finally ejected. Here I can accommodate him periodically.

Major C. E. Dutton's recent article[5] breaks off entirely with his old-fashioned comrades and looks at volcanoes from a new point of view. I always read Dutton at arm's length when I differ from him, lest the trenchancy of his style rob me of the charm of my own convictions. And the case here in question is even more disquieting. Whoever invokes radio-activity silences most of us; for if the incantation be potent enough, there is very little that the wily electron can not do. But in this instance, not a few have been in quest

[4] I have not the data at hand, but they will be found, if I remember, in Oscar Peschel's 'Erdkunde.'

[5] 'Volcanoes and Radioactivity,' *Nat. Academy*, April 17, 1906.

of radio-active fortunes supposedly stored in the bowels of the earth. In one of the last annalen, August Becker,[6] studying the lavas of Vesuvius in the Lenard's laboratory, detects no unusual radioactivity in the magmas from deep sources, while Lord Kelvin has lately girded his gravitational vestments anew, and is thundering in the *Times* for a return to the simple life, free from radio-active refinements.

We may summarize, therefore, that in each case specific evidence for the adequate occurrence or the localizations of volcanic heat is wanting. Apart from this the manufacture of volcanoes is as easy as an after-dinner discussion. Suppose, for instance, we all got to work conjointly; let me supply the broth, as I trust, thick and hot, while Elihu Thomson kneads in the energy and Major Dutton bombards the whole with α particles. Could anything withstand us? True there has been stuff predicted

"Impenetrable, impaled with circling fire,
Yet unconsumed,"

but this need not be mentioned (at least not in the summer), as it is gravely questioned whether it will fit into the periodic law, and it does not concern us if we are good.

CARL BARUS.

BROWN UNIVERSITY,
PROVIDENCE, R. I.

THE RIGIDITY OF THE EARTH.

TO THE EDITOR OF SCIENCE: In his discussions of the interior condition of the earth (SCIENCE, September 7, 1906, and elsewhere), Professor T. J. J. See advances the proposition that the interior matter of the earth is at the same time fluid and highly rigid. Taking the words in their accepted meaning this is a contradiction in terms. If the intended meaning is that deep-seated material is kept solid only by pressure, it is of course no new hypothesis. The experimental evidence for rigidity, which has been adduced by Kelvin, Darwin and others, concerns, however, only the actual present rigidity of the earth, and has no bearing upon the question whether this is or is not due to pressure.

Professor See's own supposed deduction of the earth's rigidity (*Astronomische Nachrichten,* 4104) apparently rests upon a complete misunderstanding of the meaning of modulus of rigidity. He quotes from Kelvin a definition of this modulus stated in a somewhat unusual form which seems to have misled Professor See as to its meaning, although this is made quite clear by the context. The definition quoted is from the article on Elasticity, Encyclopedia Britannica, Vol. VII., p. 805, and is as follows:

> The modulus of rigidity of an isotropic substance is the amount of normal traction or pressure per unit area, divided by twice the amount of elongation in the direction of the traction or of contraction in the direction of the pressure when a piece of the substance is subjected to a stress producing uniform distortion.

The context shows that this definition refers to a body subjected to a traction in one direction, an equal pressure in a rectangular direction, and zero stress in the third rectangular direction. The accompanying strain is the 'uniform distortion' referred to in the definition. With this understanding the definition is exactly equivalent to the more common definition which immediately precedes the one quoted, and which reads as follows:

> The 'modulus of rigidity' of an isotropic solid is the amount of tangential stress divided by the deformation it produces.

For a fluid the value of the modulus of rigidity as thus defined is necessarily zero. Professor See, however, apparently infers from the definition quoted by him that the modulus of rigidity of any body, solid or fluid, is equal to the normal pressure to which it happens to be subjected. At all events this is the basis of the method by which he computes the rigidity of the earth and of other planets. Assuming Laplace's law of density and the resulting distribution of interior pressure, he computes the average pressure throughout the earth and calls this the mean value of the modulus of rigidity for the earth. Of course, Kelvin's definition admits of no such interpretation.

L. M. HOSKINS.

PALO ALTO, CAL.,
September 13, 1906.

[6] *Annalen der Physik,* XX., p. 634, 1906.

THE INTERIOR OF THE EARTH.

To the Editor of Science: Professor Thomson's recent article on the cause for volcanic action, which begins with a reference to the theory of a liquid interior of the earth as exploded, taken in connection with a recent paper by my friend, Dr. Daly, has set me thinking as to what we mean by speaking of the interior of the earth as either solid or fluid. That if fluid it is in general highly viscous is certain; that if solid it is also often subject to stresses above its crushing strength, under which it flows like punched steel, all will agree. But are we clear as to where we are to draw the line between viscous fluid and solid? We have, on the one hand, substances, which, like the splinters of albite described by Day, are so viscous as to retain their form even when heated so that they have lost their crystalline structure and then become optically homogeneous, and we have, on the other hand, experiments like those of Adams on the flow of rock solids. I do not think we can come to any clear idea or definition without emphasizing the relation of time. Molasses candy and tar appear ordinarily as solids and crack and break as such, yet given time enough they flow, and are properly classed as viscous fluids. In geologic problems we have large quantities and long times at disposal. The argument for the solidity of the earth from its resistance to the pull of the sun and moon proves that it is highly rigid, but not at all that it may not be a viscous fluid, because the time in which the stresses are applied is relatively brief.

The scientific distinction between solid and fluid may be derived from the common idea of a solid as that which has a form of its own, while the fluid takes the form of the containing vessel, bounded by a level surface on top. It is obvious that we must give it time to take the form in question. A very viscous fluid may take a very great time, yet it will ultimately assume the same form as the other fluid. Whence we may base an ideal definition and say that anything to be classed as fluid will, in sufficient time, come to the same state of equilibrium as water, *and is not able to rest in a state of strain, but yields to a stress however small or slowly applied.* Whereas a solid, such as a crystal of quartz, might be under a light stress producing a slight strain for infinite time without any tendency to permanent distortion.

For geological purposes we do not need to deal with quite infinite time. While stresses such as those of the tides and volcanic earthquake shocks are far too quickly applied to discriminate between viscous fluids and solids, the slow erosion of a continent by the fraction of a thousandth of a foot a year, the slow attendant deposition of sediment on the ocean floor and the slow escape of energy from the interior of the earth are examples of forces so slowly applied that if there is any degree of real fluidity worth mentioning in any layer of the earth, there could be no accumulation of such stresses in it, but they would be yielded to as fast as formed.

According to a geological theory known as that of isostasy, there is something like this continuous yielding in the case of erosion and deposition, the continents being uplifted as they are eroded, while the ocean shores are depressed, so that continents float above the general earth level because they are lighter, like icebergs in water, and not because they are supported by stresses in the earth beneath. In the same way the earth is supposed to have been depressed beneath the icecap and to have risen again, tilting the shore lines of the Great Lakes, when the ice melted away. If this theory is strictly true it would seem to me that we must assume a viscous fluid substratum. But is this process absolutely continuous, or only 'steady by jerks,' the yielding occurring only after a certain degree of strain is accumulated? Upon the possibility of accumulation to some extent of very slow strain should depend the answer as to whether there is a viscous fluid or plastic solid substratum of the earth. As President McNair has suggested to me, there is an experiment now being unwillingly tried on a gigantic scale which might throw light on this. The Colorado River is about to cover some 2,000 square miles in the next 30 or 40 years with

water over 200 feet deep. Will this gradually applied extra load produce a gradual depression? This might almost seem a crucial test, and it would seem as though a few well-placed and well-determined bench marks on projecting hills, or possibly triangulation tripods, in the area to be submerged would answer the question. And it is the hope of arousing interest and causing the necessary measurements to be made that has spurred me to write this note. ALFRED C. LANE.

THE GEOGRAPHICAL DISTRIBUTION OF STUDENTS.

IN the article on 'The Geographical Distribution of the Student Body at a number of Eastern and Western Universities and Eastern Colleges,' which appeared in the issue of SCIENCE for August 10, 1906, I neglected to call attention to the fact that the showing of a number of the state universities is somewhat misleading, for the reason that many students from outside the state in which the university is located endeavor to establish a state residence, in order to escape the tuition charged to outsiders. This is true particularly with reference to the University of California, on account of the isolation and the large size of the state. Families of students from outside often establish a temporary residence in Berkeley, and a similar state of affairs no doubt exists with reference to the University of Michigan and other state universities. At California not over one quarter of the students coming to the university from outside the state and from foreign countries are so registered. RUDOLF TOMBO, JR.

Registrar.

SPECIAL ARTICLES.

THE PRESERVATION OF SURFACE CONDENSER TUBES IN PLANTS USING SALT OR CONTAMINATED WATER CIRCULATION.[1]

THE prevention of electrolytic corrosion of condenser parts where they are subject to contact with condensing water that contains electrolytic properties has been a serious problem with condenser engineers at sea as well as on land, where the condensing water contains salts in solution. This action is especially destructive where the cooling water is contaminated further with chemicals or with sewage.

In the great steam plants of New York city where the water bills extend into thousands of dollars per annum, in fact, are approximately one tenth of the fuel bills, this is an important condition bearing upon the cost of the hourly power unit, but the attempt to use surface condensers in the past for the purpose of saving this waste has not been accompanied with any degree of success. The highest economy demands such precautions as shall leave the hot-well water coming from the condensers in a proper condition for feeding the boilers.

The waste incident to the inability to save this water in stationary generating plants has caused the construction of surface condensing apparatus at such plants as that of the Brooklyn Edison Company at Bayridge, and of the Metropolitan Street Railway Company at 96th Street, New York City.

At the time the design of the Long Island City Power House of the Pennsylvania Railroad was undertaken, it became evident that true economy in the operation of a plant which would have under ordinary circumstances an annual water bill of about $100,000, when the plant has been fully put into service, justified an attempt to save the water from the hot well for replenishing the boilers. This seemed to demand a thorough investigation of the matter of condenser protection where the circulation cooling water was an electrolyte as it was in this case.

The site where this plant was to be constructed was at Long Island City near the harbor front, and the plant was designed to contain, when fully constructed, fourteen 5,500 K.W. generating units. With such an equipment and with an ordinary loading, the amount of boiler feed water required per annum would cost in the neighborhood of $100,000.

In the investigation of possible methods for

[1] Read at the Ithaca meeting of the American Association for the Advancement of Science, June 29, 1906, before Section D—Mechanical Science Engineering.

preventing the rapid destruction of condenser tubes and parts, an effort was made to find out if the condenser engineers of the country did not have suitable information as to the nature of the action tending to destroy the thin tubes and preventing tightness in the condenser, or had not made trials to indicate effective methods of protection. The most competent opinion that we could get was that if we could adjust the difference of potential due to stray ground traction or other currents to a value of less than three volts, we should have no difficulties; that the trouble was all due to stray ground currents from electric railways and that stray currents from lighting plants had little or nothing to do with the corrosion. They further stated that all that was necessary was to insulate from the possible inflow into the condenser of stray currents from traction operations. It had been found that these currents were already destroying the city water pipes of the vicinity along which they were traveling and to which connection would have to be made.

With a view to discovering a method of protection, we carefully investigated this statement based on the action of a device at the Brooklyn Edison Company's Bayridge Plant caring for this condition, and found it had been an abject failure, ending in the abandonment of surface condensers, and the installation of elevated jet condensers at considerable expense, and consequent wasting of the water of condensation. Numerous other instances, more or less efficiently handled, were found. Some of the condensers in other steam plants were so designed and the connections so made that it was absolutely essential to permit the sea-water from the main spaces to pass into the steam space of the condensers by the actual removal of tubes, thereby preventing the re-use of feed water from the hot wells, even if they had been tight otherwise.

It became evident at once that there was really nothing accurately known about the destructive actions that were taking place in condensers and that a systematic study of the situation for Long Island City was demanded before we should decide on the type of condenser and the wisdom of trying to use hot-well water in the boilers.

To that end, we measured the stray currents and we found that the voltage of the railroad rails in the terminal freight yard of the Long Island Railroad at points between the power house and the river was at times as much as nine volts above the potential of the river; that this caused a flow of current to the harbor and a destruction of water pipes and other things in the railroad yards, and that anything that was done would have to be not only able to compensate for this nine volts but must further provide for the control to fit modifications thereof in such a way as to prevent reverse current actions and corrosion of other things. In other words, with the peak of the load on the Brooklyn Rapid Transit, the voltage would go to nine volts; and as the load sagged off it would decrease, until it was only a volt or two. Therefore, whatever was put in must be thoroughly controllable from time to time by switchboard appliances.

In order to properly study the real conditions a number of large glass jars were provided and various combinations of metals were immersed in samples of water taken from the river at Long Island City, of sea water from off Far Rockaway, as well as of pure water.

It became evident that the effect of samples of water from the East River was much more violent than that of ordinary sea water. It was further observed that there was a local action going on which was galvanic, and that the amount of stray currents had something to do with the polarization of the surfaces in galvanic action, making the galvanic action exceedingly violent and destroying thin copper tubes at a very rapid rate. There would be punctures of these tubes in four or five days' time which would be fatal to the commercial requirements, producing a very serious repair item in order to maintain the condensers sufficiently to permit their being used to return the reclaimed or hot-well water to the boilers.

In other words, it would render it impossible to keep them in a suitable condition, as the

water would be contaminated with salt-water leakage.

It soon became evident by observation of the several combinations in these cells, that there was a violent local action between the zinc and the copper of the brass tubes which were in contact with the electrolyte, and that this increased in the reaction as it progressed in stagnant conditions.

It then became necessary to find a method more comprehensive than the proposed simple counter-electromotive force for the neutralization of the traction companies' stray currents. Further experiments with plates immersed in the cooling water samples showed that by interposing a counter electromotive force against the galvanic couple which should exceed in pressure the voltage of the galvanic couple, the actions of the electrolytic corrosion ceased. The difference in potential between the zinc and the copper for the Long Island City harbor water was found to be 0.4 of a volt. Zinc and copper were selected in these experiments because the condenser tubes were to be made of 60 per cent. copper and 40 per cent. zinc. It became evident that when unconnected, or electrically separated, plates were placed in this electrolyte, if they were of composite construction and had sharp projections into the fluid, raised by cutting and prying up with a knife, they would have these projections promptly destroyed, and that if an electric battery having a pressure exceeding that of the couple in the East River water was caused to act to produce a counter current, and having a pressure exceeding that of the galvanic couple, the capacity of this electrolyte to drive off atoms of the mechanically combined metals in the alloys used was overcome and corrosion was arrested.

It, therefore, became desirable to not only carefully provide the balancing quantity of current to equal the stray traction currents arising from the ground returns of railway and other service, but to add to this the necessary voltage through a cathode placed in the circulating water in such a way as to bring to bear electrolytic action which would prevent the galvanic action due to this current coming into contact with alloys of mechanically combined metals such as the brass tubes.

It became evident that the influence of various foreign substances in the East River water made the galvanic couple as between an atom of zinc and an atom of copper greater than for open sea water, and it was found to be at times as high as 0.42 of a volt. With this known it was planned to put a pressure of 0.6 of a volt on the anode in order to overcome this action and prevent the separation of the zinc molecule from the surfaces and the consequent breaking down of the tubes.

In order to accomplish these two things, it was first necessary to so install the condensers as to prevent undue amounts of stray currents flowing through them, thus tending to reduce the amount of power required to prevent injurious action of these currents and otherwise to neutralize them. This was done by insulating the joints in the piping and from ground connections and even lining the large water connections with glass melted on to the surface.

To furnish electromotive force, a 3-K.W. motor generator was provided. It was of the form used for electroplating. By means of a system of wiring, switchboard apparatus and appliances, together with ammeters and voltmeters for measuring quantities and pressures, and a connection to an outlying anode in the condensing supply intake at its harbor end, this generator was planned to provide current to neutralize the stray currents in the condenser structure to any extent that they had passed the insulated joints in the supports and connections, as well as through the columns of water in the pipe connections, and then to adjust the additional voltage needed to counteract and prevent the galvanic action.

This led to much discussion as to methods and the reasons why the corrosion was prevented; and it became necessary, in order to get at the facts in the matter, to review the history of electrolytic conduction. A reference to Faraday's Laws and to the results of the experiments of Helmholtz and Clausius, explained the nature of this electrolytic con-

duction and the reasons for its action. The best explanation is summed up in Professor Oliver J. Lodge's 'Modern Views of Electricity,' chapter four on 'Electrolytic Conduction,' as follows:

1. Electrolytic conduction is invariably accompanied by chemical decomposition, and in fact only occurs by means of it.

2. The electricity does not go through, but with the atoms of matter, which travel along and convey their charges something after the manner of pith balls.

3. The electric charge belonging to each atom of matter is a simple multiple of a definite quantity of electricity, which quantity is an absolute constant quite independent of the nature of the particular substance to which the atoms belong.

4. Positive electricity is conveyed through a liquid by something equivalent to a procession of the electro-positive atoms of the compound, in the direction of the current; and at the same time, negative electricity is conveyed in the opposite direction by a similar procession of the electro-negative atoms.

5. On any atom reaching an electrode, it may be forced to get rid of its electric charge, and, combining with others of the same kind, escapes in a free state; in which case visible decomposition results. Or it may find something else handy with which to combine, say on the electrode or in the solution; and in that case the decomposition, though real, is masked, and not apparent.

6. But, on the other hand, the atom may cling to its electric charge with such tenacity as to stop the current; the opposition force exerted by these atoms upon the current being called polarization.

7. No such opposition force, or tendency to spring back, is experienced in the interior of a mass of fluid; it occurs only at the electrodes.

The first three of these statements constitute a summary of Faraday's Laws of Electrolysis.

The claim was made, immediately upon the application of this apparatus, that the electricity coming from the anode, which in this installation was of cast iron but which ordinarily would be of carbon, would short-circuit on to the very ends of the tubes instead of passing through the tubes to the several points which might be exposed to galvanic action. This, however, does not seem to be the case, and in fact is entirely accounted for by the following remarks from the above-mentioned work on 'Modern Views of Electricity':

But it may be asked, 'If the atoms in each molecule cling together by their electrostatic attractions, and, as there are an enormous number of atoms between the two electrodes, how comes it that a feeble electromotive force can pull them apart and effect decomposition; moreover, how can the electromotive force needed to effect decomposition help varying directly with the thickness of the fluid between the plates?' It does not depend upon anything of the kind; the length of the liquid between the electrodes is absolutely immaterial. This proves that throughout the main thickness of the liquid no atoms are torn asunder at all. Probably, they frequently change partners, one pair of atoms not always remaining united but occasionally getting separated and recombined with other individuals. During these interchanges there must be moments of semi-freedom during which the atoms are amenable to the slightest directive tendency, and it is probably these moments that the applied electromotive force makes use of.

The reality of such a state of continual interchange between molecules has been forced upon chemists by the facts of double decomposition, such facts as the interchange of atoms between strongly combined salts where their solutions are mixed so as to form very much weaker compounds; the proof that such compounds are formed being very clear in the case when they happen to be insoluble.

The fact that the most infinitesimal force is sufficient to effect its due quota of decomposition has been proved most clearly and decisively by the experiments of Helmholtz.

Moreover, electrolytic conduction is perceived to be scarcely of the nature of true conduction: the electricity does not slip through or among the molecules; it goes with them. The constituents of each molecule are free of each other, and while one set of atoms conveys positive electricity, the other set carries negative electricity in the opposite direction; and so it is by a procession of free atoms that the current is transmitted. The process is of the nature of convection: the atoms act as carriers. Free locomotion of charged atoms is essential to electrolysis.

Professor Lodge also says:

For any element, whatever, the number of atoms liberated in any time is equal to the number of

atoms of hydrogen liberated in the same time divided by the 'valency' of the element as compared with hydrogen. This law was discovered by Faraday; and appears to be precisely true: and inasmuch as the relative weight of every element is known with fair accuracy, it is easy to calculate what weight of substance any given current will deposit or set free in an hour, if we once determine it experimentally for any one substance.

By this means, we succeeded in properly adapting the sizes of the generating and other apparatus. All connections were made in a manner to insure a uniform voltage of the various parts of the condenser to prevent local action, each connection being so made and provided with such measuring instruments as to insure ready adjustment to effect this. The apparatus was designed in accordance with the above statements. Its operation has extended over a period of fourteen months, and with the exception of about ten tubes which have become pitted, the results have been satisfactory.

When the condenser was planned, the condenser manufacturer was instructed to slope the tubes down one inch in the direction of flow; but when he did so, it was forgotten that the middle inclination, if parallel to the first and third passes, would then be up-hill for the circulating water, and that when the condenser was shut down all the water would drain out of this middle section except that in the bottom tubes. These bottom tubes it has been found have become somewhat corroded, although not seriously.

The cause for this result having now been found, its prevention has been effected by perforating the diaphragm in the condenser head to permit prompt drainage of these tubes when the condenser is taken out of active operation.

The efficiency of the apparatus amply justifies the expense of its installation, while its operation is not expensive and the plant here described will now be followed by other protecting plants of the same character.

W. W. CHURCHILL.

QUOTATIONS.

THE NEXT INTERNATIONAL TUBERCULOSIS CONGRESS.

THE International Tuberculosis Congress takes place at intervals of three years, and the latest was held in Paris last autumn. The next, therefore, is due in 1908, and Washington has been selected as the place of meeting. It seems a far cry from now to the autumn of the year after next; but the American National Association for the Study and Prevention of Tuberculosis, which has general charge of the arrangements, evidently intends that this meeting shall be notable among congresses, and with laudable forethought has already got its plans something more than mapped out. As an initial step it set itself the task of collecting a sum of $100,000 towards the expenses, but resolved to get this amount in a fashion quite impossible in any country on this side of the Atlantic. In other words, the minimum subscription was placed not at five shillings but at five thousand dollars, in the belief that there would be no difficulty in finding at least twenty citizens of the United States ready for such an object to put their hands into their pockets to the tune of £1,000 each. Nor does it appear likely that these rose-colored expectations will be falsified, for about half the sum desired is already in hand. There is a double object, however, in this early collection of the sinews of war. A sum of $100,000 lying at interest at American rates for a couple of years will enable another scheme to be fulfilled. This is to award prizes of considerable value to the authors of the best papers sent to the congress on certain selected subjects, such as municipal control, bacteriological treatment and sanatoriums, as also to anti-tuberculosis societies which can show the largest increase in membership since the congress of 1905, and to the city, wherever situated, which can claim the greatest improvement in its phthisis mortality rates during a corresponding period. The exact subjects have not yet been finally determined, but it is understood that an announcement of them is to be expected before very long. A further novel suggestion which

seems likely to be adopted is that by way of making it worth while for those in Europe to cross the water, and also of affording a certain latitude, the congress shall officially last three weeks. Only the middle week, however, is to be devoted to scientific meetings and discussions, it being proposed that the first week shall be given up by visitors to exploring some of the other great cities of the United States north of Washington, in which official arrangements will be made for their reception, and the third week to similar official visits to cities southwards. The idea is that there may be many who could reach Washington some little time before the scientific proceedings commence, but would have to leave immediately on their termination, while others could spare plenty of time afterwards, but none before, and that by placing the discussions in the middle week America will be able to show public hospitality to visitors of either class.—*The British Medical Journal.*

CURRENT NOTES ON METEOROLOGY.

CLIMATE AND ALTITUDE IN AFRICA.

The tempering effect of altitude, even within the tropics, is well known. The vice-governor of the Congo Free State, in a recent description of a journey over the Uganda Railroad (*Mouvement Géographique,* No. 16, 1906), brings out this point in his notes on Nairobi, an important town on the line west of Mombasa, about half-way between the Indian Ocean and Victoria Nyanza, at an elevation of 5,450 feet. Here it is possible to raise several varieties of European fruits, vegetables and cereals; the European population is increasing, and many of the white settlers have brought their families. It is further stated that they have no desire to return to their native land. If this be true, it marks a radical departure from the usual rule for white settlers in the tropics, but it is doubtless an exaggerated statement, or has its origin in the fact that most of the Europeans have been at Nairobi but a short time and have not yet attempted to bring up their children there.

Concerning German East Africa, the government of that district has recently issued a circular for the use of white colonists who intend to settle in the Kilimanjo province. The province consists chiefly of grassy steppe, and the industries must be general agriculture and stock-raising, in the main. The altitude mitigates the heat, although the region is only about 200 miles south of the equator.

Major Gibbons (*Geogr. Journ.,* March) has studied the western part of the high plateau region of British East Africa with a view to ascertaining its adaptability for European settlement. Most of the plateau is 6,000 feet above sea-level. Major Gibbons believes that this, as well as other higher altitudes in this part of Africa, will be classed as healthy countries, and that they will have considerable agricultural development.

MONTHLY WEATHER REVIEW.

Recent numbers of the *Monthly Weather Review,* Vol. XXXIV., 1906, have contained the following notes and articles of general interest: 'The Relation between Storm Movement and Pressure Distribution,' by E. H. Bowie; 'Climatology of Haiti in the Eighteenth Century,' by C. F. Talman; 'Vertical Air Currents,' by F. W. Proctor, who notes that he has several times had toy kites lifted by vertical currents during summer anticyclonic weather, thus showing the presence of small irregular rising bodies of air. A case of 'Snow formed by Mixture of Warm and Cold Air' is described by R. W. Gray, observer at Atlantic City, N. J. On February 6 last snow fell during a part of the day when the sky was perfectly clear. At times the flurries were quite heavy. Condensation seemed to occur at not more than 75 to 100 feet above ground, and in a region of mixture of cold northwest land wind with a warmer, damp ocean wind. Consul-General Skinner, at Marseilles, describes the new method of frost protection in use in the vine-growing regions. A newly-invented preparation, known as the 'Fumigène Mortier,' packed in boxes containing about nine pounds of black powder, and costing 1.50 franc each, is much used in producing thick smoke, which has proved very effective in

checking radiation and thus decreasing the danger of frost. Professor Cleveland Abbe contributes some further notes on the life and work of Espy. In connection with a letter from a correspondent in Curaçao, who attributes to deforestation in that island certain electrical effects which now produce less rain than formerly, Professor Abbe ('Drought and Atmospheric Electricity') takes occasion to point out what is known regarding the connection between rain and electricity. In a series of observations on 'The Zodiacal Light,' Dr. Maxwell Hall reaches conclusions which would relegate this phenomenon to the department of astrophysics, the influence of the atmosphere being only to render obscure the fainter details. In a note on 'Cloud Banners,' reference is made to the report that heavy columns of smoke or steam were ascending from the peak of Mount Rainier on March 6 last. Public attention was attracted by the phenomenon, and it was eagerly watched. In reality, it was a cloud banner of the ordinary type, developed in a warm southerly wind. A similar appearance, in December, 1904, led to the sending of an expedition up the mountain by a Seattle newspaper. A review of a recent paper by Brückner on the influence of the oceans on precipitation over the continents brings out the fact that if the figures and underlying assumptions are taken as accurate, it appears that were the influence of the oceans eliminated, the continents would still receive four fifths of their present precipitation.

CENTRAL LOW PRESSURE IN A TORNADO.

A FEW years ago there was no barograph record from the center or from near the center of a tornado. Almost every year now some tornado in the United States passes near enough to a Weather Bureau station to leave some record of its existence on the curve traced by the self-recording barometer, yet the number of these records is not yet so large that new ones are uninteresting or not worth noting. The tornado at Meridian, Miss., March 2 last, whose passage caused a considerable loss of property and resulted in the death of 23 persons, was within 250 yards of the local office of the Weather Bureau. The barograph pen dipped .16 inch, and recovered almost immediately, making a straight line down from the main part of its curve. This is the usual form of tornado pressure curve. A facsimile of the original tracing may be found in the *Monthly Weather Review,* 1906, p. 118.

NOTES.

'SOME Meteorological Results of the Scottish National Antarctic Expedition,' by R. C. Mossman, appear in the *Scottish Geographical Magazine,* Vol. 22, 1906, pp. 252–272. This is a more complete discussion than has hitherto been published, and is illustrated by means of curves and wind roses. The most important results of the *Scotia* expedition have already been noted in SCIENCE.

THE rainfall of a region little known meteorologically, German Southwest Africa, is discussed by T. Klengel in *Das Wetter,* 1906, beginning with the April number and extending through July.

THE optical effects resulting from the dust thrown out in the recent eruption of Vesuvius are briefly discussed in the July number of *Das Wetter.*

R. DEC. WARD.

BOTANICAL NOTES.

A NEW FLORA OF COLORADO.

ABOUT thirty years ago Professors Porter and Coulter prepared a very useful 'Synopsis of the Flora of Colorado,' and ten years later this was expanded by the junior author into his well-known and widely used 'Manual of the Botany of the Rocky Mountain Region.' In the two decades since the appearance of the latter so much has been done in the collection and closer study of the plants of the Rocky Mountain region that these old books no longer represent the present state of our knowledge of the species and their distribution. Dr. Rydberg's 'Catalogue of the Flora of Montana and the Yellowstone National Park' (1900) gave some idea of what additions and changes would have to be made in

a comprehensive treatment to-day of the plants of the region. Several years ago the officers of the Agricultural Experiment Station of Colorado felt the need of having the growing botanical collections of the station determined more accurately than was then possible with the available manuals and other publications, and appealed to the director of the New York Botanical Garden for such help as he could afford them. The ultimate result of this appeal is a well-printed octavo volume of more than 450 pages, entitled the 'Flora of Colorado,' and published as Bulletin 100 of the Colorado Experiment Station. It is the work of Dr. P. A. Rydberg, whose acquaintance with the Colorado flora is based upon much actual study and field work in different parts of the state, in addition to the rich collections in the herbarium of the New York Botanical Garden. It has been known for some time that he has had in preparation a manual of the botany of the whole Rocky Mountain region, and the present volume is thus a sort of prodrome of that work.

The plan of the book is similar to that of the very useful 'Flora of Pennsylvania,' prepared a few years ago by Dr. Porter. By convenient keys in the beginning of the book the orders are sufficiently characterized for recognition; then on the designated page of the volume by another key the families are briefly characterized; and so in like manner under each family is a key to the genera, and under each genus, a key to the species. Finally after the specific key each species is given a separate paragraph, including the authority, habitat, general distribution in North America, particular distribution in Colorado, altitude, and now and then a synonym. It is thus a synoptical manual, and has the merit of maintaining the identity of order, family, genus and species, a matter of no small importance to the beginner who wishes to know something more than the mere names of his plants. A failure to maintain such distinctions is a grave fault of many of the local manuals accompanying botanical text-books. Dr. Rydberg's book will no doubt at once become the handbook for the student and collector in Colorado, for which it is admirably adapted.

From the preface we learn that it contains 'over 700 genera, and 2,900 species' of fernworts and flowering plants, and that 19½ per cent. of these are composites; 9 per cent. grasses (*Poaceae*); 6½ per cent. *Fabaceae;* 5 per cent. *Brassicaceae;* 3½ per cent. sedges, etc.

The nomenclature is modern, and the treatment of genera and species quite radical, yet the author has not published any new genera or species in the book, thus setting a good example, which it is to be hoped will be followed by other botanists who prepare similar floras. It is a good piece of work, and the officers of the experiment station are to be congratulated upon their liberality and foresight in providing for its publication.

THE NORTH AMERICAN CHAREAE.

Twenty-seven years ago Dr. B. D. Halsted published in the *Proceedings* of the Boston Society of Natural History a twenty-page paper entitled the 'Classification and Description of the American Species of Characeae,' including characterizations of all of the species then known in North America, viz., of *Nitella* 8 species, *Tolypella* 1, and *Chara* 9 species and 6 varieties. Three years later Braun's 'Fragmente' increased these numbers to *Nitella* 21 species, *Tolypella* 3, and *Chara* 15, besides many varieties and 'forms.' Now we have a paper, 'The Chareae of North America,' published by Dr. Charles B. Robinson in the *Bulletin* of the New York Botanical Garden, which shows what progress has been made in the last quarter of a century in the study of these interesting plants. As indicated in the title this paper is limited to the *Chareae,* a subfamily represented in this country by the genus *Chara* only, and yet the author finds more species (50) than were recorded in all our genera by previous students. Of these species fifteen are here described for the first time, while ten varieties are raised to specific rank. Of the new species two each come from New York, New Jersey, Canada, Michigan, Florida and Mexico, while Kansas, New Mexico and Illinois add one each.

The paper, which covers 64 pages, includes a ten-page structural and historical introduction, followed by a key to the species of *Chara*. Following the key are full descriptions of all of the species, with the type locality, distribution, illustrations and exsiccatae for each species. Suggestive critical notes are appended in many cases, adding much to the value of this important contribution to our knowledge of this interesting group of plants.

A MOSS BOOK.

SOME weeks ago Part III. of Dr. Grout's 'Mosses with Hand-lens and Microscope' came to hand, continuing the work from page 167 to 246. In this part we have the completion of the family *Tortulaceae*, and the treatment in succession of *Encalyptaceae*, *Orthotrichaceae*, *Schistostegaceae*, *Splanchnaceae*, *Funariaceae*, *Meeseaceae*, *Timmiaceae*, *Aulocomniaceae*, *Bartramiaceae*, *Bryaceae* and *Leskeaceae*. The two families to which the most space is given are *Orthotrichaceae* and *Bryaceae*, which together take up more than half of the pages of this part. The illustrations and text maintain the high standard set by the author in the two preceding parts. The statement is made that two more parts will complete this important and very useful work.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

CENTRAL BUILDING OF IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

ON June 8, 1906, the new central building of the Iowa State College of Agriculture and Mechanic Arts was dedicated. Hon. W. J. Dixon, in speaking of the construction of the building, said:

> The building is 216 feet long by 112 feet in depth. Floor area 98,000 square feet. The building contains 1,892,738 cubic feet of materials. The base is of Georgia granite and the outer walls of Bedford stone. The roof is tile set in concrete. Construction is fire-proof throughout. The plumbing, heating and lighting is of the most approved modern systems. The cost of the completed building is $375,000.

The architects were Proudfoot & Bird, of Des Moines; the builder was Henry W. Schleuter, and the superintendent of construction was Dean Anson Marston. The furniture cost $52,000.

The commencement address was made by Dr. F. W. Gunsaulus, of Chicago. The following number of degrees were conferred: B.S.A., 34; D.V.M., 4; B.M.E., 19; B.C.E., 27; B.S. in E.E., 21; B.S. in Min.E., 8; B.S., 14, three men and eleven women; M.S.A., 6; C.E., 1; M.S., 2; B.D.S., 1. One honorary degree of M.Ph.

At a meeting of the board of trustees on June 1, R. Earle Buchanan was made assistant professor of general bacteriology and Estelle D. Fogel was made instructor in botany.

The following departments have rooms in the new central building: English, history, mathematics, civics, economic science, modern languages, elocution and oratory. There are also general offices for the board and the secretary, the purchasing committee, the president and faculty, and a reception room, treasurer's office, and the rooms of the department of botany. The department of botany occupies most of the upper floor and the attic story.

L. H. PAMMEL.

SIR WILLIAM PERKIN AND THE AMERICAN JUBILEE OF THE COAL TAR INDUSTRY.

WE have already noted the British celebration in commemoration of the fiftieth anniversary of the discovery of the dye-stuff mauve by Sir William Perkin. American chemists decided to celebrate the foundation of the coal tar industry independently, and Sir William Perkin and Lady Perkin left Liverpool on the *Umbria*, on September 22, to be present at a banquet which will be given at Delmonico's, on October 6.

The American committee submitted to a public meeting, held May 28, 1906, the following program: (1) To invite Sir William Perkin to be present at the American celebration as the guest of the Americans. (2) The presentation to Sir William Perkin of a personal token. (3) The foundation of a Perkin medal to be awarded annually to an American chemist for distinguished work in applied

chemistry. (4) The establishment of a nucleus of a fund for the foundation, at the Chemists' Club, in New York City of a reference and circulating library, covering the entire field of theoretical and applied chemistry, which is to be in charge of a salaried librarian and to contain duplicate sets, one of them to be used for circulation among American chemists.

It was estimated that $5,000 would be amply sufficient to cover the expenses of the personal token and the Perkin medal, while the sum of at least $50,000 would be necessary for placing the library on a permanent basis.

At the dinner the first Perkin medal and a silver tea service will be presented to Sir William Perkin, and there will be addresses on the development of the coal tar industry and after-dinner speeches.

SCIENTIFIC NOTES AND NEWS.

The Smithsonian Institution was represented by Mr. S. F. Emmons at the International Geological Congress held in Mexico City from the sixth to the fourteenth of the present month and by Dr. Walter Hough at the fifteenth International Congress of Americanists, held in Quebec from the tenth to the fifteenth. Dr. Hough also represented the U. S. National Museum.

Professor Wilhelm Hittorf, professor of physics at Münster, will be presented with a marble bust on the occasion of his jubilee, which will shortly be celebrated. Professor Hittorf has himself given 25,000 Marks for the scientific work in the Münster Academy.

Dr. Max Toepler, professor of physics at the Dresden Technological Institute, celebrated on September 7 his seventieth birthday.

Dr. A. R. Crook, for the past twelve years professor of mineralogy and economic geology at Northwestern University, has been appointed curator of the Illinois State Museum of Natural History at Springfield. During the past summer Professor Crook has visited museums of natural history in this country and abroad with a view to studying their methods of administration and installation.

Dr. Maynard M. Metcalf, professor of biology in the Woman's College in Baltimore since 1893, and now professor-elect of zoology in Oberlin College, has received the appointment to the Smithsonian seat in the Naples Zoological Station for the months of March and April, 1907. Dr. Stewart Paton, formerly of Johns Hopkins University, whom Dr. Metcalf succeeds at Naples, by extension of a former appointment, will occupy the Smithsonian seat for five months from the first of October of the present year. It is announced that the Smithsonian has decided to renew its lease of a table at the station for an additional term of three years from January 1, 1907, and that applications, which are acted on in order of receipt, may now be submitted. In view of the number of students who desire to avail themselves of this opportunity for study at Naples, a Smithsonian appointment is not approved for a longer period than six months, though in exceptional cases an extension may be asked for and granted, if such action does not interfere with the occupancy of other applicants.

The first meeting of the California Branch of the American Folk-Lore Society during 1906–07 was held September 11, at 8 P.M., in South Hall, University of California, Berkeley. Mr. Charles Keeler presided. On motion a nominating committee was appointed consisting of Professor Dresslar, Professor Fryer and Mrs. Dickson. The committee reported the following nominations for officers for 1906–07:

President—Charles Keeler.
First Vice-president—John Fryer.
Second Vice-president—W. F. Bade.
Treasurer—S. A. Barrett.
Secretary—A. L. Kroeber.
Councilors—Charles F. Lummis, W. C. Mitchell, Mrs. Thomas B. Bishop, John E. Matzke, C. Hart Merriam, E. J. Molera.

On motion the report of the committee was adopted, the nominees being thereby elected. Professor A. L. Kroeber thereupon gave an address on 'California Indian Myths and Songs,' illustrated by graphophone records.

We learn from *Nature* that the government of Cape Colony has placed a sum upon the

supplementary estimates toward the expenses incurred in carrying out investigations upon defects in ostrich feathers, under the direction of Professor J. E. Duerden, of Rhodes University College, Grahamstown.

THE New York *Evening Post* says: "Signor Giolitti, a son of the prime minister of Italy, accompanied by his wife, has arrived from Naples. He is a professor of mathematics, and has come to America to attend courses of lectures at some of the universities in this country."

MR. WELLMAN has arrived in Norway, on board the *Frithjof*, with his balloon, which will be sent to Paris for improvements to be made in the motor, which broke down constantly. The wireless apparatus which had been installed in Spitzbergen for communication with Hammerfest was also a failure, telegrams not having been received from Norway.

THE opening exercises of the 153d academic year of Columbia University were held on September 26. The annual academic address was delivered by W. H. Burr, professor of civil engineering, upon 'The Technical School and the University.' Professor Burr was followed by Dr. Hermann Schumacher, of the University of Bonn, first Kaiser Wilhelm professor of German history and institutions in Columbia University.

ON the evening of October 10 Professor C. J. Keyser, of Columbia University, will deliver a lecture on 'The Space Concept of Lucretius and Blaise Pascal' before the mathematical section of the Brooklyn Institute of Arts and Sciences.

DR. LUDWIG BOLTZMANN, eminent for his work in theoretical physics, of which subject he was professor in the University of Vienna, has committed suicide. He was born in Vienna in 1844, and after qualifying as docent at the university was successively professor at Gratz, Munich and Leipzig.

THE death is announced of Khan Bahadur Yusuf Sharif a Mohammedan geographer and topographer, who carried out important surveys in India and in Persia.

NEW YORK state civil service examinations will be held on October 13 for assistant bacteriologist in the State Department of Health at a salary of $1,500, and for assistant sanitary chemist in the same department at a salary of $720. There will also be an examination for the position of archeologist in the science division of the Educational Department at a salary of $900. This position requires an acquaintance with the Indian tribes of the state.

THE U. S. civil service commission announces an examination on October 17 for the position of engineer in the department of sewer and waterworks construction, Manila, at a salary of $4,000, and for the position of assistant engineers at salaries of $1,800.

AN arrangement has been made by Dr. Samuel G. Dixon, state commissioner of health in Pennsylvania and Dr. Allen J. Smith, professor of pathology in the University of Pennsylvania, by which the pathological laboratories of the Medical School shall be used by the state for bacteriological and other work. Dr. Herbert Fox has been put in charge of the work.

THE firm of Friedrich Krupp, Ltd., of Essen, plans the erection of a technico-physical laboratory at a cost of $500,000.

THE American Breeders' Association will hold its regular winter meeting at Columbus, Ohio, on January 15–18, 1907. The visiting association will conduct its daily sessions at the university and board of trade buildings as the guest of the Ohio Board of Agriculture, the Ohio State University and the Ohio agricultural societies. The most successful and foremost workers and investigators in breeding and heredity in animals and plants are being secured for the program. A prominent feature will be the reports from the forty-three committees among whom the work of the society is distributed. The American Breeders' Association has an annual membership of over 950 as well as 42 life members. Volume II., the second annual report, is just off the press.

ACCORDING to Reuter's Agency, the Indian government has under consideration a scheme

for reclaiming the Rann of Cutch, a work which, if carried out, will be similar to that undertaken by the Dutch in the Zuider Zee. The Rann of Cutch is a waste, at some seasons water, at others land, and it is proposed to reclaim it by closing the inlets from the sea, which are narrow. The water, which is everywhere shallow, would then evaporate rapidly, leaving heavy saline deposits. These, it is thought, could be washed out and drained away by a great canal to be constructed from the Indus. The application of scientific agriculture to the reclaimed land and the construction of a railway linking Karachi and Bombay would complete the proposed scheme.

UNIVERSITY AND EDUCATIONAL NEWS.

FOREIGN journals state that the Grecian government recently received from St. Petersburg a legacy of about eight million roubles (over $6,000,000), which was left in the beginning of the last century by a rich Grecian merchant, of the name of Dombolis, with the condition that after the lapse of a definite time a second Grecian university should be built in Corfu out of the capital and interest, and be called the Kapodistrias University.

WE learn from the *Journal of the American Medical Association* that the former professor of legal medicine and toxicology at Montpellier, France, Dr. Jaumes, who died recently, aged seventy-two, made the medical faculty his legatee. A fund producing an income of $1,200 was left to found a chair of general pathology and therapeutics, and a prize in legal medicine was also endowed in both the medical and law departments. Another fund representing an income of $2,000 reverts ultimately to the medical faculty, and $6,000 was presented to the local medical and other scientific societies.

MR. ALBERT CRANE, of Stamford, Connecticut, has given $100,000 to the Divinity School of Tufts College.

IMPROVEMENTS have been made during the summer at Cornell College which will greatly strengthen the scientific work. New and enlarged quarters have been provided for the engineering department and the departments of geology, physics and biology. Quantitative and organic laboratories have been provided for the chemical department. A large amount of apparatus has been secured for the different subjects.

A NEW dormitory for men has been erected at the University of the Pacific to replace the one damaged by the recent earthquake. It will contain fifty-six sleeping rooms (all outside rooms) each supplied with hot and cold water, fixtures for electric and gas light, and steam heat. Each floor will have six bath rooms and four needle-shower rooms with tile wainscoated sides and floors. The Y. M. C. A., library and club rooms will be 25 x 25 feet each. The building is being constructed of wood, steel and cement, with metal tile roof, will be practically fire-proof, and practically earthquake proof. It will cost about thirty thousand dollars. The fourth story of East Hall has been removed, the roof lowered and the entire building bound securely by steel rods. North, South, East, West, Central and Music Halls have been replastered and decorated. A new athletic field is being laid out, and a large plunge bath will be put in back of the gymnasium. One of the heating plants, destroyed by the earthquake, is being replaced by a large plant of sufficient capacity to heat all the buildings in place of two plants as at present.

THE buildings of Groningen University were partly destroyed by fire on August 30. The natural history museum and the chemical laboratories were among the buildings destroyed.

IT is reported that Zürich University will increase the lecture and laboratory fees chargeable to foreigners, with the idea of lessening their numbers.

DR. FRANCIS FRANCIS has been promoted to a chair of chemistry at University College, Bristol, vacant by the appointment of Dr. Travers to the directorship of the Indian Institute of Science, to be established at Bangalore.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FIFTEENTH INTERNATIONAL CONGRESS OF AMERICANISTS.

THE Fifteenth International Congress of Americanists was held at Quebec, September 10 to September 15. While the number of students of early American history and of American ethnology in attendance was not large, the papers presented were of great value, and the local interest in the proceedings was considerable. The congress had an individuality of its own, being attended by many missionaries from all parts of Canada, who contributed to the proceedings reports on the tribes among whom they are laboring; while South America and Central America, which generally occupy by far the greatest parts in the proceedings of the congress, were not so strongly represented.

Delegates to the congress were sent by England, which was represented by Dr. A. C. Haddon and Dr. D. Randall McIver. France sent Professor Léon Lejeal and Comte de Perigny. From Germany, Professor and Mrs. Eduard Seler and Dr. Paul Ehrenreich were present. Mexico was represented by Señor Leopoldo Batres and Señor Santiago Sierra. Unfortunately the representation from the United States was not as good as it should have been. Harvard University and Yale University had sent full delegations, but the number of anthropologists from New York and from Washington was small. No anthropologists from Chicago or from San Francisco were in attendance. The local interest in the congress was well sustained,

and it may be hoped for this reason that the Quebec session may have contributed towards exciting a permanent interest in the subject in Canada. The program embraced in all 91 papers, but only about one half of these were read.

The congress was opened on Monday morning by Sir Louis A. Jetté, Lieutenant-Governor of the Province of Quebec, and was welcomed by representatives of the government and of the city of Quebec. The reading of papers began on Monday afternoon. The first meeting was devoted to the subject of the French in Canada and to historical papers. On this afternoon an important contribution by Abbé Gosselin, communicating unpublished documents relating to the Indians of Louisiana, was presented. Other important communications made during this meeting were by Professor E. L. Stevenson on a Hondius map recently discovered by Father Fischer; by Dr. Berthold Laufer on the history of the introduction of maize into eastern Asia; by M. de Villiers du Terrage on the history of Louisiana; and two papers—one by Mr. Rivard, of Quebec, another by Professor A. F. Chamberlain, of Worcester—on the Canadian French dialect. In the evening Señor Batres reported on his interesting excavations at Teotihuacan, and Father Jones spoke on the location of the Huron villages.

The program of Tuesday morning was devoted to subjects relating to Mexico and Central America. Professor Seler, of Berlin, discussed a number of interesting specimens from the collection Sologuren at Oaxaca, the most remarkable of which is a vase with a design almost identical with those of Peru. Dr. Tozzer, of Cambridge, communicated briefly the results of his interesting studies of the Lacandones of Chiapas, in which he showed that many of the ancient customs of Central America still survive. Dr. George Grant MacCurdy, of New Haven, followed with a discussion of the decorative art in the pottery of Chiriqui. He tried to show that a great many of the decorative motives of the prehistoric tribes of this area may be derived from a representation of the armadillo. Tuesday afternoon opened with additional papers relating to Central America and South America. A number of the excellent paintings from Chichen Itza by Miss A. Breton, Bath, England, were exhibited by Dr. Tozzer, who also gave interesting notes on the Maya language spoken in Yucatan, in which he particularly brought out the occurrence of a true inclusive and exclusive first person in these dialects. Professor Lejeal presented a joint paper by himself and Mr. E. Boman, of Paris, on the Calchaqui question, in which he strongly opposed the stand taken by Professor J. Ambrosetti, who believed he had discovered a relationship between the Calchaqui and the Pueblo Indians of North America. Professor Lejeal proved the close relationship between the Andean culture and that of the Calchaqui. A general review of the distribution and number of South American linguistic stocks was given by Professor Chamberlain. Father Jetté, of Alaska, sent in a brief description of the Tinné tribes of southern Alaska. This paper was supplemented by another one sent by Rev. John Chapman, who treated the Athapascan tribes of Anvik, Alaska. His notes contain a number of interesting Indian texts and a detailed description of the festivals of the tribe. The afternoon closed with a paper by Dr. Dixon on linguistic relationships within the Shasta-Achomawi stock, in which it was shown that a number of languages of northern California, notwithstanding their marked differences, are members of the same stock.

On Wednesday morning the principal papers were by Mrs. C. O. Mason, Miss Natalie Curtis and Miss A. de Cora, in

which practical efforts to keep alive and to revive Indian art were discussed. Miss de Cora described her efforts as art teacher at the Indian school at Carlisle, while Miss Curtis, after some general remarks on Indian music, rendered a number of Indian songs which was a demonstration of the beauties of Indian music. A number of papers by Dr. Dorsey on the Pawnee were read by title. In the afternoon a pleasant reception was tendered to the members of the congress by Lady Jetté.

Thursday morning opened with a discussion by Dr. A. Hrdlicka, of Washington, of those remains of man which are believed to prove his antiquity on this continent. On the whole, his conclusions were negative, in so far as the anatomical differences between these remains and the present types of Indians are concerned. Father Morice read a paper on the position of woman among the Tinné tribes, and Professor Boas communicated a résumé of ethnological problems in Canada. A general review of the principles of government among the Indians of Canada was given by Dr. Roy, of Lévis. A number of papers on the Algonquin tribes of Canada, contributed by a number of missionaries, were read by title. On Thursday afternoon Father Pacifique read a paper on the Micmac, and a description of the religion of the Assiniboine was contributed by Abbé Gauvreau. Dr. Clark Wissler, of New York, read a paper on the diffusion of culture on the Plains of North America. A similar subject was treated in a paper by Professor A. L. Kroeber, of San Francisco, Cal., on the ceremonial organization of the Plains Indians of North America, in which a strong plea for a more detailed study of this interesting subject was made. The peculiar tendency to assimilate the culture of neighboring tribes found among the Tinné was discussed in a paper sent in by Dr. P. E. Goddard, of Berkeley, Cal. Another paper dealing with the question of migration was that by Professor Cyrus Thomas, who discussed the earliest probable movement of tribes of our continent. On Thursday evening Laval University received the Americanists in the gardens of the university.

On Friday morning a series of illustrated papers on Mexico and Central America were read. The principal among these were those contributed by Professor Seler, who discussed parallels in Mayan manuscripts, the monuments of Huilocintla, and who also contributed comparative studies on the ruins of Yucatan. Dr. Seler also presented brief abstracts of a paper by Dr. K. Sapper, of Tübingen, on the present distribution of the Choles and Chorties, and of another by Dr. W. Lehmann, of Berlin, on ancient Mexican mosaics in the Ethnographical Museum of Berlin. Dr. Peabody made some remarks on the manuscript contributed by Dr. George F. Kunz, discussing some features of the Bishop collection of jade. The morning session ended with a paper by Dr. Walter Hough, of Washington, on the ancient population of the Gila Salt River. On Friday afternoon Abbé Forbes presented an interesting study of the proper names of the Iroquois, and Abbé Rousseau discussed the question of Hochelaga. Dr. D. E. Dionne, of Quebec, spoke on the translations of the Lord's Prayer into Indian languages, and Professor Boas gave a sketch of the grammar of the Ponca. A number of important papers were presented by title, owing to the absence of the authors. Among these, a description by James Mooney of the Cheyenne Indians, and a presentation of Cheyenne grammar by Rev. R. Petter, deserve special mention. In the evening the members of the congress were conveyed by special train to Montmorency Falls, where the city of Quebec tendered them a reception.

The program of Saturday contained only

a few papers, one a discussion by Dr. Walter Hough of two great culture-plants of America, the palm and the agave. Further, the desirability of a uniform phonetic alphabet was discussed in a paper sent in by Mr. Jules Geddes, and another by Mr. J. N. B. Hewitt, which were discussed by Father Morice. At the following business meeting Vienna was chosen as the place of meeting of the next congress, which is to take place in 1908. After the business meeting the congress was closed by the president, Dr. Robert Bell, of Ottawa.

The success of the meeting at Quebec, and its peculiar character, were due particularly to the efforts of Monsignor J. C. K. Laflamme and of Dr. D. E. Dionne, the secretary-general. After the close of the congress, a number of excursions were made, which continued until Monday, the seventeenth.

A number of publications were presented to the congress by various organizations. The government of Quebec presented two books on the geographical names of Quebec, one by Dr. Roy, the other by Dr. Rouillard. The government of Mexico presented a special publication on the excavations at Teotihuacan, and three other contributions from the Department of the Inspection and Preservation of Archeological Monuments, all prepared by Mr. Batres. The University of California sent the important papers by Professors Putnam and Merriam on cave explorations in California. The government of Ontario sent copies of its archeological report, which contains a general summary of Canadian ethnology, prepared by a number of contributors. The University of Pennsylvania dedicated to the congress the first part of the second volume of the *Transactions* of the Department of Archeology, containing articles on the decorative art of Crete, by Edith H. Hall; notes on Xochicalco, by Miss Breton; notes on the Western Eskimo, by Dr. Gordon; and notes on an engraved bone from Ohio, also by Dr. Gordon. Mr. Charles P. Bowditch presented to the congress a paper relating to his Maya studies. The American Anthropological Association presented a useful summary of anthropological activities in the United States since the meeting of the congress in New York in 1902. A special number prepared by the publishers of *Globus* unfortunately did not reach Quebec in time. The Society of Americanists of Paris presented a set of its publications to the congress, and copies of the last number of its publications to all the members of the congress. Mr. Teobert Maler sent a valuable set of blue-prints of his plans and drawings.

THE AMERICAN MATHEMATICAL SOCIETY.

THE thirteenth summer meeting and fifth colloquium of the society were held at Yale University, extending through the week September 3–8. Monday and Tuesday were devoted to the presentation of the thirty-four papers on the program of the regular meeting. President W. F. Osgood and ex-President E. H. Moore occupied the chair. Forty-six members were in attendance. The following new members were elected: William Beebe, Yale University; J. B. Clarke, San Francisco Polytechnic High School; E. C. Colpitts, Cornell University; Brother Constantius, St. Louis Christian Brothers College; G. W. Droke, University of Arkansas; R. M. Ginnings, State Normal School, Kirksville, Mo.; Harriet E. Glazier, Western College for Women; C. O. Gunther, Stevens Institute; W. G. Hurwitz, University of Missouri; G. O. James, Washington University; B. F. Johnson, State Normal School, Cape Girardeau, Mo.; E. B. Morrow, Princeton University; G. B. Obear, Brown University; F. M. Pedersen, New York City College; G. A. Rose, Hardin College; R. L.

Short, Chicago, Ill.; Betty Trier, Mount Holyoke College; J. W. Withers, St. Louis Teachers College. Thirteen applications for membership were received. The total membership of the society is now about 540.

A committee consisting of Professors Bôcher, Van Vleck and Townsend was appointed to report to the council at the October meeting a list of nominations of officers to be elected at the annual meeting in December. Steps were also taken toward amending the constitution to include the editorial committee of the *Transactions* in the membership of the council, and toward increasing the sale of the Chicago Mathematical Papers and the Boston Colloquium Lectures published by the society.

One of the most valuable of the society's institutions, and one as regards which it stands alone among similar organizations, is the colloquium, or course of lectures on recent important advances in the science given at intervals of two or three years by specialists in the fields covered. The fifth of the series opened on Wednesday morning and extended to Saturday noon. Three courses were given, as follows: By Professor E. H. Moore, five lectures 'On the theory of bilinear functional operations'; by Professor E. J. Wilczynski, four lectures on 'Projective differential geometry'; by Professor Max Mason, four lectures on 'Selected topics in the theory of boundary value problems of differential equations.' Forty-three persons attended these courses.

On Tuesday afternoon the visitors were conducted through the grounds and buildings of the university. Thursday afternoon and evening were devoted to an excursion to the shore of Long Island Sound. Throughout the meeting, the Graduates Club was the center for large and small gatherings. The hospitality of the university and its officers was gratefully acknowledged by appropriate resolutions and will long be remembered by all who were present at the meeting.

The following papers were read at the summer meeting.

A. R. SCHWEITZER: 'Systems of axioms for projective geometry.'

A. R. SCHWEITZER: 'Concerning abstract geometrical relations.'

O. D. KELLOGG: 'The behavior on the boundary of harmonic functions of a region.'

F. R. SHARPE: 'The motion of a viscous gas.'

R. D. CARMICHAEL: 'Multiply perfect numbers of three different primes.'

LUDWIG STICKELBERGER: 'Zur Theorie der vollständig reduciblen Gruppen die zu einer Gruppe linearer homogener Substitionen gehören.'

W. B. FITE: 'Irreducible linear homogeneous groups whose orders are powers of a prime.'

ARTHUR RANUM: 'The group of classes of congruent matrices and its application to the group of isomorphisms of any abelian group.'

R. G. D. RICHARDSON: 'On the reduction of multiple integrals.'

G. D. BIRKHOFF: 'On a certain class of sets of normed orthogonal functions.'

W. B. CARVER: 'Associated configurations of the Cayley-Veronese class.'

L. E. DICKSON: 'On commutative linear algebras in which division is always uniquely possible.'

L. E. DICKSON: 'Uniform definitions of the abstract forms of the various known systems of linear groups.'

L. E. DICKSON: 'Criteria for the irreducibility of functions in a finite field.'

L. E. DICKSON: 'On the theory of equations in a modular field.'

JAMES MCMAHON: 'The differential geometry of the general vector field.'

W. A. MANNING: 'A note on transitive groups.'

C. H. SISAM: 'On systems of conics lying on surfaces of the third, fourth and fifth orders.'

VIRGIL SNYDER: 'Plane quintic curves which possess a group of linear transformations.'

MAX MASON: 'The expansion of an arbitrary function in terms of normal functions.'

MAX MASON: 'The boundary value problems of differential equations of hyperbolic type.'

EDWARD KASNER: 'The inverse problem of dynamics.'

EDWARD KASNER: 'The geometry of dynamical trajectories.'

J. W. YOUNG: 'General theory of approxima-

tion by functions with a given number of parameters.'

J. I. HUTCHINSON: 'On loci the coordinates of whose points are abelian functions of three parameters.'

L. P. EISENHART: 'Applicable surfaces with asymptotic lines of one surface corresponding to a conjugate system of another.'

H. B. LEONARD: 'On the factoring of composite hypercomplex number systems.'

FRANK MORLEY: 'Reflexive geometry.'

G. A. MILLER: 'Generalization of the groups of genus zero.'

E. B. WILSON: 'On divergence and curl.'

E. B. WILSON: 'Oblique reflections and unimodular strains.'

E. B. WILSON: 'Double products and strains in n dimensions.'

F. R. MOULTON: 'A class of three dimensional periodic orbits in the problem of three bodies, with applications to the lunar theory.'

OSKAR BOLZA: 'Weierstrass's theorem and Kneser's theorem on transversals for the most general case of an extremum of a simple definite integral.'

The next meeting of the society will be held at Columbia University on Saturday, October 27. The San Francisco Section met at the University of California on Saturday, September 29.

F. N. COLE,
Secretary.

THE EDINBURGH MUSEUM.

THE Edinburgh museum challenges attention. It is significantly *useful,* and seems to attempt to make its collections supplementary to class-room study; nor is there any hesitancy shown in displaying specimens to the limits of its capacity, as long as they contribute in the slightest degree to the need of the student. Its methods of installation are not expensive or elaborate, but they show painstaking care, considerable ingenuity and promise to be made progressively better and more complete.

There can be no question as to the richness of its possessions in geology and lithology and Scottish mineralogy, nor is there reason to look askance upon their splendid biological demonstrations. The writer enjoyed the opportunity of only one or two visits to its crowded halls, and then confined his attention to the departments of natural history, which are in it associated with very satisfactory, in some instances most valuable, collections, illustrating machinery, fictile art, ceramics, design, ethnology, sculpture, architecture, industries, chemistry, navigation, archeology and house furnishings.

There are evidences in many places of unfinished plans, of reorganization and experiment, but the museum indubitably claims the attention, and admiration, in some ways, of every museum promoter and officer, and its own relations to the inquisitive Scotch public are wholesome and helpful.

Criticism in some particulars might naturally be provoked as where in one hall or room, mammals, birds, insects, crustaceans, fish, shells, echinoids and hydrozoans are grouped together, and in another invertebrate fossils and birds, while in a third there are discovered birds, invertebrate fossils and corals. This peculiar juxtaposition is doubtless referable to want of space, capacious as the museum is, and not in all instances to the aims of comparative study.

The museum is on Chamber Street between South and George Bridge Streets, beyond St. Giles cathedral, not far from the university, and opposite the Watt College. It consists of a long (250 feet) three-storied skylighted oblong section with terminal buildings disposed at right angles to the axis of the main structure, and similarly arranged in three stories with skylights, except that their anterior portions are also illuminated by the introduction of wall windows. Back of the main series of halls or galleries, as they might be called, are three large rectangular

halls with basement floor, and galleries, also deriving their illumination from above. The lighting generally is most serviceable, for, by reason of the immense skylight space, of absolutely clear glass, the narrowness of the galleries, and the height of the ceilings, no hopelessly heavy shadows are cast; and, at least when the writer was there, on a brilliant day, the light was superabundant. As a matter of fact, white shades covered the skylights and helped advantageously to diffuse and diminish the light. Reflections in the flat cases around the balustrades of the central opening, on the galleries, were noticeable, and of course annoying, but could be quickly dissipated by holding a hat above them.

One of the striking features in the natural history exhibit is the elaborate art expended upon dissected animals, the explanation of their parts and the beauty and thoroughness of many of the preparations. Zoantharia, sea urchins, star-fish, insects, crustaceans, worms, fish, are thus accurately dissected, their organs named, helpful addenda of elucidations and suggestions appended, all clearly printed, and assisted by drawings, frequently colored. These preparations, as with many of the insects and crustacea, and spiders are mounted dry, and others are in alcohol in flat jars, the object being quite usually on blue glass with red threads connecting each part with its printed *name,* which latter appears on the plate or board, which holds the specimen. The dissections of the thornback ray, the torpedo, the dog-fish, the skate, with developing young are superb. The amphibia are similarly treated, and near them is noticed a splendid exhibit of the osteology of the cod. Further on in this section are some absolutely unimpeachable examples of the phases of bird feathering, and the tract-distribution of feathers illustrating pterylography. Amongst these is a very succinct and forcible demonstration of the terminology of the feathers of the ring dove.

Throughout this section the exceeding cleverness and technical power of Mr. W. Eagle Clarke, and Mr. P. H. Grimshaw are in evidence. Many, and most of the difficult subjects, are their personal handiwork, always, I believe, submitted to the approval of Dr. Traquair, the director of the museum, who is now about to retire.

The mollusca are also ecologically discussed in diagrams, selected specimens and dissections. There are important groups of specimens illustrating types of shells, their external and internal features, old and young conditions, terminology of parts, the muscular impressions, in the shells clearly delineated by red painting, also hinges and teeth, the nature of the margins of the valves, pedal, siphonal and byssal openings, position of umbones, terminology of the multivalvular forms; forms of shell, as dextral, sinistral, elongate, subulate, tubular, cylindrical, ovate, globose, turbinate, involute, conical, cordate, etc.; the ornamentation, as granulate, pustulate, subnodose, reticulate cancellate, spinose, clathrate, costate; colors; variations of sculpture as so well shown in *Pecten glaber, Liguus virginia, Helix nemoralis;* protection as in *Xenophora conchyliophorus* (with its attached shells); and the varying aspects of the periostracum.

The examples under the above heads are mounted on gray cards with black centers, explained by clear clean printed labels. In the molluscan biology excellent preparations most graphically instruct the visitor in the anatomy of the common shells, and some, as those of the cephalopods, merit pronounced praise. The morphological and embryological study is continued in this hall throughout the animal kingdom.

The specimens of fossils from Cambrian

to Pleistocene are superior, though they seem to lack effectiveness from their irregular distribution in various halls; thus in the hall of fossil fish there is a fine collection of living fishes, sponges and *graptolites*. Many of the invertebrate fossils are grouped with the living shells, not of course at all confusedly, but in the same hall in wall cases. Noticeable in one group is an interesting collection of fossil footprints from the new Red Sandstone of Corncockle Muir, Dumfriesshire, formed by the late Sir Wm. Gardine, Bart, and containing the specimens described and figured by him in his 'Ichnology of Annandale.'

The Devonian fossil fish easily take precedence amongst the fossil collections, and they possess an unmistakable distinction. They make up a wonderful collection. Here are the Devonian genera, *Asterolepis, Bothriolepis, Cephalaspis, Coccosteus, Cyroptychius, Diplopterus, Dipterus, Drepanaspis, Eusthenopteron, Holoptychius* —a superb slab, three feet long, shows a group of one species of this genus—*Glyptolepis, Homosteus, Osteolepis, Phaneropluron, Pteraspis, Pterichthys, Thrusius, Tristichopterus*. The carboniferous Jurassic and Tertiary fishes are also of unusual value.

Amongst the fossil invertebrates attention may be justly called to the collection of specimens in the Carboniferous (especially instructive cephalopoda) and Jurassic sections, the interesting *hippuritidæ*, of the chalk, and one splendid example of *Requienia* (*R. ammonia*, Goldfuss) from the Meocomian of France. The Jurassic and Triassic Cephalopoda are superior in individual excellence, though the collection does not seem very large. The polished Triassic Ammonoidea are certainly handsome. The Paleozoic fossils are naturally of great interest, but incomparably poorer in quality and numbers than the exhibition of similar material from the same horizons in New York.

The fossils are mounted on buff boards with printed divisions, printed and written labels, and are somewhat incongruously associated with a collection of comparative craniology in the glass-fronted cases beneath them. In this same room is a collection of shells, evidently intended for comparative or morphological study, as it is far from being very extensive in numbers or in species. Models of *Arion* and *Limax* were noticed and apparently a cleverly mounted skin of *L. agrestis*, L. The fossil and living crustacea in this hall, in wall cases, were excellent, and the *Eurypterida* decidedly valuable.

A very excellent instance of an industrial exhibit may be profitably quoted as suggestive at least to curators contemplating similar objects. It is the care devoted to an instruction in the making of Wedgewood ware. Here under raw materials are placed boulder flint, gravesend flint, calcined flint, limestone, chertstone, compact gypsum, flint dried and ground to a firm mass as used in the glazes, raw Swedish feldspar, Swedish feldspar fired in the biscuit oven, gray marl, seggar clay, a mixture of gray, black and red marls passed through a couple of rollers, blue ball or poole clay. Blue clay fired in the biscuit oven, black clay, another kind of ball clay, china clay, Cornish clay or kaolin (a fine white clay obtained from the decomposed feldspar which is washed out of certain Cornish granites), china clay with sand washed out, china clay fired in the biscuit oven, native china clay before being washed, hard Cornish stone fired in the highest heat of the biscuit oven, china clay fired in the highest heat of the biscuit oven, blue clay fired in the highest heat of the biscuit oven, black clay, gray marl, red marl, all fired in the biscuit oven, calcined flint broken or stamped, flint knockings—

the pieces discolored by oxide of iron picked out as waste, American feldspar calcined in the glass oven, calcined feldspar ground and ready for use in Parian, soft Cornish stone (slightly decomposed, most decomposed, etc.), hard and soft Cornish stone fired in the biscuit oven, hard and soft Cornish stone ground and mixed, as used for the body and glaze of ware, pigments, glazes, slips, frits, chemicals (about ninety glass bottles enclose these ingredients), and the various stages of the ware with implements, in a superb and very precious exhibit of vessels, vases and plaques, partly chronological.

The archeological and ethnological exhibits are of great merit and value. A small group of objects labeled 'chemical balance and other apparatus used by Professor Joseph Black' will attract the reverent attention of chemists.

The general mineralogical collection is an excellent and adequate representation of the mineral retinue of species from the native elements to the hydrocarbons, though it is quite lacking in distinction or phenomenal beauty. It is well arranged, for purposes of study, in flat cases around the central opening under the skylight, and in flat cases about the walls, with larger specimens above and below the latter. There is noticeable in it good spodumene from Norwich, Conn., and hiddenite from North Carolina, a remarkable pink topaz from the Ural Mountains, three crystals of euclase, some striking scolecite from Iceland, excellent torbernite, superior barite crystals, a handsome halite group, an attractive exhibit of hydrocarbons, and a small complementary collection of pseudomorphs—of much interest—amongst which the pseudomorph of vesuvianite after garnet deserves mention. A beautiful crystallized gold specimen from Ballarat, weighing six and three fourth ounces, a large platinum nugget, good atacamite, crystals, corundum, bournonite, green fluors, apophyllite from India, and the handsome ruled agates from the Faroe Islands are also memorable.

In lithology the constituents of rocks are shown, their combination in rock structure and examples of characteristic rocks, as acid, subacid, basic, metabasic, etc.; while structure and phase receive illustration under metamorphism, shearing, crumpling, foliation, lamination, ripple-marks, etc. Many crystallographic drawings appear throughout, and labels are sometimes very elaborate, as take, for instance, this one under pseudomorphism:

Mould-Formation, with Removal of Pattern Quartz Coating Galena.—There has, in this specimen, been two successive depositions of Galena, with investiture of quartz. After the removal of the first formed crystals of galena, a second and larger set of crystals of galena has been laid down upon the first formed layer of quartz. These in turn have been invested by a layer of quartz, and thereafter have been themselves removed; Leadhills, Scotland.

The climax of excellence in the museum, in the opinion of the writer, is reached in the hall devoted to Scottish geology. The exhibit here of rocks and minerals is remarkably effective, and in its lithological aspects quite extraordinary. Here are gathered together the minerals of Scotland, views of its geological scenery, with a display of rock specimens, luminously referred to position by maps, marked with pins and numbers, correlated exactly with the specimens of rocks near them. There are also relief maps dissected, colored and explained, and on the walls the fossils of Scotland with a long series of prehistoric flints, while upright A-shaped cases engage immediate notice from interesting and handsome specimens of geological structure, mineral masses and lithological phases contained in them. This hall contains a wealth of Scottish mineral treasures, and will reward the student by a

comprehensive showing of Scotland's geological history and mutations.

Among its extraordinary features he will be attracted to the Heddle collection of cut and polished agates with their labeled parts and exposition. It is well known that Dr. Heddle took a very particular interest in the genesis of agates and related mineral phenomena, and the little leaflet which may be purchased at the door of the museum to-day may be regarded as a complete expression of his opinions—convictions in this matter he conscientiously repudiated—on the subject. It has been prepared by Mr. J. G. Goodchild. The extensive display of cut agates will surprise visitors and seems, perhaps, rather needlessly elaborated. But these small nodules, cut across their longest diameter and polished, are very attractive, and the short attached printed labels reveal differences in structure and composition which are very interesting. It is impossible to even epitomize Dr. Heddle's views on this subject in this article, but it may interest readers to learn that the late Dr. Heddle, of St. Andrews, formed a very large collection of agates, gathered from all parts of Scotland, principally with the view of obtaining definite information as to the developmental history of these forms of silica. This collection, on the death of Dr. Heddle, passed into the hands of Mr. Alex. Thoms, of St. Andrews, who, already a generous donor to the Scottish mineral collection, in 1898 presented to the museum 1,000 of Dr. Heddle's agates, all of them selected and typical examples. It is these specimens which are now carefully exhibited in their surprising variety in the hall of the Edinburgh Museum, enclosing its examples of Scottish geology.

The Edinburgh Museum is a plain and, probably, inadequately equipped museum; it is neither ostentatious nor unimportant, it contains a great accumulation of material, and this brief notice may draw attention to it, amongst the numerous visitors to the Athens of the north. Such sketches of museums, imperfect and fragmentary as they may be, cumulatively help to increase the interest taken in museums by the lay and professional member.

L. P. Gratacap.

ISRAEL COOK RUSSELL.

The senate of the University of Michigan has adopted the following memorial as offered by the committee, Professors Lombard and D'Ooge:

Again and for the third time within the short space of two months, the hand of death has been laid heavily upon us, and we are called to mourn the loss of another honored and beloved colleague.

Professor Israel Cook Russell entered upon his duties as professor of geology in this university in the autumn of 1892, and was stricken down in the midst of his work by an illness which after a few day terminated his life, on May 1, 1906. He was born near Garratsville, N. Y., December 10, 1852, son of Barnabas and Louisa Sherman (Cook) Russell. His ancestors were early settlers in New England. He was fitted for college at the Rural High School, Clinton, N. Y., and Hasbrook Institute, Jersey City. He entered the University of the City of New York in 1869, and was graduated bachelor of science and civil engineer in 1872. After pursuing graduate studies at the Columbia School of Mines, he was given the degree, master of science, by the University of New York in 1875. In 1874 he went to New Zealand as a member of the United States Transit of Venus Expedition, and in this connection made a journey round the world. On his return home in 1875 he was appointed assistant professor of geology in the Co-

lumbia School of Mines, where he remained two years. In 1878 he became assistant geologist on the United States Geological Survey west of the 100th meridian, and devoted one season to field work in Colorado and New Mexico. The following year was spent in European travel. In 1880 he was appointed assistant geologist on the United States Geological Survey. It was not long before his merit was recognized and he was promoted to geologist of the survey, a position which he held throughout the rest of his life.

Professor Russell was more than geologist and geographer, he was an ardent student of physiography. In his preface to 'Rivers of North America' he wrote:

> When investigators of surface geology and geography made their bold explorations into the vast arid region of the southwest, they discovered a land of wonders, where the mask of vegetation which conceals so many countries is absent and the features of the naked land are fully revealed beneath a cloudless sky. It was in this arid region of strong relief that a revival of interest in the surface forms of the earth was engendered. The seeds of what is practically a new science—physiography—gathered in this land by J. S. Newberry, J. W. Powell, G. K. Gilbert, C. S. Dutton and others, when carried to other regions, bore abundant fruit.

Russell belonged to this new school. He studied the surface of the earth as it exists to-day, as a book where one can read not only the past history of the world, but prophecies as to its future destiny. It was the forces which nature uses to mould the world that chiefly interested him, and throughout his books one sees him tracing the transformations of the earth under the influence of ice and water, and the cooling of the earth's crust.

It was his desire to study the forces of nature where they are most clearly revealed that led him to endure the hardships of the mountains and the deserts of the west. In order to visit these regions he attached himself to the United States Geological Survey, and while he did the work of the government, he gathered the rich harvest of scientific data which he gave to the world in his many publications. But he was interested not alone in the processes which are wearing away and building up the surface of the earth; the conditions which exist to-day, and how they may be utilized for the good of mankind, were carefully observed. This is evidenced by his thoughtful study of the water supply of the arid regions of the west, and his conscientious work on the water supply of our own community. Ann Arbor owes him a debt of gratitude for the earnest attention and large amount of time which he so freely gave for the benefit of his fellow-citizens.

Many of his expeditions were of the nature of a reconnaissance of the surface geology of regions which had never been traveled by any trained observer. In 1889 he was sent by the United States Geological Survey on an expedition up the Yukon and Porcupine rivers, Alaska, a journey of about twenty-five hundred miles through an almost unknown wilderness. In 1890 and 1891 he conducted two important explorations in the region about Mount St. Elias, under the joint auspices of the United States Geological Survey and the National Geographical Society, during which special attention was given to the study of glaciers and to geographical explorations.

It is hard to think of the quiet, modest, somewhat frail-looking man, our colleague and friend, as the celebrated 'pioneer explorer' of the wilds of Alaska. Yet all who have accompanied him on his expeditions bear witness to his boundless energy and tenacity of purpose, his strength and endurance, and his resourcefulness in

grappling with the difficulties with which nature guards the secrets of her fastnesses.

During his connection with the University of Michigan, he carried on extensive explorations for the United States Geological Survey in many of the western states, and for the past five years of his work for the survey has given especial attention to the question of the water supply and irrigation of those vast areas, which need only water to be converted into fruitful fields. In these expeditions he explored northwestern Nevada, the Mono Valley of California, central Washington, the Cascade Mountains of northern Washington, southern Idaho, the south and southeastern part of Oregon, central Oregon, Nez Perces County of Idaho, and the Snake River Valley of Idaho.

Eighteen of the annual reports of the United States Geological Survey contain papers by him, these papers covering more than fifteen hundred pages, and being richly illustrated by photographs, maps and diagrams, picturing the topography of the country through which he traveled. The 'Geologic History of Lake Lahontan, a Quaternary Lake of Northwestern Nevada,' is a monograph of nearly three hundred pages, and his paper 'The Newark System' is a still more extensive monograph.

Glaciers had for him, as for every true mountain climber, a fascination. In 1883 he wrote a fifty-page paper on the 'Existing Glaciers of the United States.' It was in 1890 and 1891 that he made two expeditions to Mount St. Elias, where he nearly lost his life, first attempting to land on the wild coast of Alaska, and, later, on the mountain itself.

Professor Russell, in writing of the first expedition, says: 'The country visited proved of such great interest both to geologists and geographers that it was decided to review the study of the various problems it offered during the following year.'' The way in which he carried through the second expedition is perhaps as good evidence as we have of the character of the man. The decision to send the expedition was not reached until May 17. That night Russell left Washington for Seattle. On arriving there he found that the revenue cutter *Bear* would leave for Alaska May 23. This gave him a week, but in that time he engaged his men and secured all the instruments, camp equipment and provisions needed for a prolonged stay in the wilds. He went without any trained assistants, only taking six camp hands, three of whom fortunately had been with him the year before. As the land was approached, Mount St. Elias could be seen one hundred and fifty miles away. The sea was calm, but the huge rollers of the Pacific were breaking on that rugged coast, which made landing exceedingly dangerous. In the successive attempts to land the outfit, the boats were repeatedly capsized, and a lieutenant, four sailors and one of the men of the expedition were lost. A delay necessarily resulted, and this delay prevented Professor Russell from reaching the top of the mountain. There is only a short interval when the mountain is free from snow-storms, and he was caught in the first storm of the year. Most of us know the story of how, when within striking distance of the top, he found that his men had failed to bring certain instruments and how he sent them back to the base camp, remaining alone on the glacier. Then came the snow. He saved himself by digging a hut in the side of a drift and there he stayed for three days, until the storm cleared. He has said that he could have reached the top of the mountain, but that he knew if he did he would never return; so he was forced to retrace his steps. The knowledge

which he gained of the mountain in these two expeditions he freely imparted to Prince Louis of Savoie, Duke of Abruzzi, and thus ensured the success of the Italian expedition. The reports of his expeditions to Mount St. Elias are found in a paper printed in the *National Geographic Magazine*, and in the reports of the United States Geological Survey. In these papers the glaciers of Mount St. Elias are described, and he has written at least ten other papers on glaciers of North America and on glacial action, besides his well-known book on these subjects.

Professor Russell became an authority not only on glaciers and the effects of ice and water upon the configuration of the earth, but an authority also on the forces which are the cause of earthquakes and volcanic action. When the Island of Martinique and St. Vincent were visited by the terrible eruptions of Mt. Pelée and La Soufrière in 1902, he was asked by the National Geographical Society to go to the islands and observe the phenomena. In addition to his report to the society, and his book on volcanoes, he is the author of ten or more papers on volcanic phenomena and their results.

During the summers of 1904 and 1905, Professor Russell worked for the Michigan State Survey in the southern part of the northern peninsula of Michigan. The report of the work of 1904 has been published, but that of 1905, although finished, is still unprinted. It is entitled 'Surface Geology of Menominee, Dickinson and Iron Counties of Michigan.'

Another paper on the geology of Michigan, entitled 'On the Drumlin Area of Northern Michigan,' was read convocation week, 1905, before the Geological Society of America at Ottawa. It was at that meeting that Professor Russell was chosen president of the society. We are all familiar with his work on the water supply of Ann Arbor, the report of which was published by the city council, 1905.

There remain three unpublished papers to be mentioned. One of these is the folio to accompany the map of the United States Survey of the Ann Arbor Quadrangle. This deals with the marl deposits and the hard rocks of the region. Another is the paper on 'Ideals Concerning Municipal Water Supplies,' which he read at the meeting of the Michigan Academy of Science, March, 1906, and which will appear in the reports of the academy. And finally there is a paper of 12,500 words in typewritten form, which he probably intended to use after revision as his presidential address at the next meeting of the Geological Society of America. It is entitled 'Concentration as a Geologic Principle.' In addition to these there remains a large amount of manuscript on the volcanoes of Martinique and St. Vincent, apparently designed to be used in book form.

In addition to his many scientific reports, papers and monographs, represented by more than one hundred titles, he published five books: 'Lakes of North America,' 1895; 'Glaciers of North America,' 1897; 'Volcanoes of North America,' 1897; 'Rivers of North America,' 1898; 'North America,' 1904.

His first book, aside from the monographs which have been mentioned, was not written until he had passed fifteen summers in the field, studying nature face to face. His books, therefore, embody the mature judgment of a man who through long years of work in the laboratory of the geologist had become a trained observer, and acquired a personal knowledge of the facts of which he was to treat. A naturally keen insight into physical problems had been strengthened by his early training, and he was able to study the earth as

one would examine a vast machine, and to check the speculations suggested by his fancy, by sound common sense and good judgment. The modesty which was so characteristic shows itself everywhere in the tone of his writings, at the same time that his self-reliance and the earnestness of his convictions led him to express himself with definiteness, and to impress his readers with the justness of his conclusions. His writings are widely known and frequently quoted abroad as well as in this country. They are wonderfully even; they are all good; and it is hard to assign to any one of them a special preeminence.

In 1886, he visited the Mono Valley region of California, and made a preliminary examination of its geology for the United States Geological Survey. In his library there is a reprint of his report of this expedition—'Quaternary History of the Mono Valley, California'—and on the reprint there is the word 'incomplete' in his handwriting. The Mono Valley region is a charming mountainous country, to the south of the Yellowstone Park, resembling Switzerland except for the lack of snow on the mountains. The country is now being rapidly opened up, and the enthusiastic alpine climbers there are anxious that it should be explored and made known to tourists. The first report of Professor Russell was so excellent that he was to have been sent by the survey this summer to complete the work which he began so well twenty years ago.

The best evidence of the success of a scientific man is to be found in the esteem shown him by men of his own branch of science. This Professor Russell possessed to a high degree, and evidence of their recognition of his ability is to be found in the honors which they paid him.

He was a fellow of the Geological Society of America, and was elected its president for 1906; a fellow of the American Association for the Advancement of Science, and vice-president in 1904; a fellow of the National Geographical Society, and a member of its board of directors (twice this society sent him on important expeditions); a member of the Michigan Academy of Science, and its president in 1902; a member of the Congrès Géologique Internationale; and of the American Alpine Club, of which he was one of the directors. He was honorary member of the Appalachian Mountain Club, and corresponding member of the Geographical Society of Philadelphia, and of the Scottish Geographical Society. He was chairman of the section of geography and a speaker in the section of physiography at the Congress of Arts and Science, held in St. Louis in 1904. He received the degree of doctor of laws from the University of New York, his alma mater, in 1897. He was generally recognized as among the foremost of the geologists of the country, and had just received an advantageous call to a prominent university. The University of Michigan has been most fortunate to have been able to have had his valuable services for so long, and has met with an irreparable loss.

He was a scientist of international renown, whose writings and explorations were constantly increasing the reputation of this university. He was a scholar of high ideals, whose interest in research work was great, and whose example as a devoted student and tireless worker made itself felt in all our circles. He was a teacher who made his students feel the importance of scientific methods and true knowledge. He was a high-minded, modest, true gentleman, who made himself beloved by all who learned to know him, and most by those who knew him best. His kindly manner, his sense of humor, his playful wit, dry

and droll, but never caustic, and his chivalrous spirit, will always linger in our memory.

We desire to tender to the bereaved family of our lamented colleague our profound sympathy, and we order spread upon the records of the senate this minute, in remembrance of our appreciation of his work and life among us.

WARREN P. LOMBARD,
MARTIN L. D'OOGE,
Committee.

May 7, 1906.

SCIENTIFIC BOOKS.

Les Révélations de l'écriture d'après un controle scientifique. ALFRED BINET, Docteur ès Sciences, Directeur du laboratoire de psychologie physiologique. Librairies Félix Alcan et Guillaumin réunies. Paris, 108 Boulevard St. Germain. 8vo. Preface. March 24, 1906.

Dr. Binet continues his excellent work, beginning with the 'Philosophie du raisonnement' and 'Recherches experimentales par l'hypnotisme' (1886), which preceded 'Animal Magnetism' (1888), 'Psychic Life of Micro-organisms' (1889), and 'Les altérations de la personalité' (1892); by commencing a new series of studies of certain fetishes which have become rooted in the beliefs of a large number of people.

These are graphology, phrenology and chiromancy. A study of such subjects by a master is of the greatest value to the world, and hence a considerable space is given to the review of the first on the list in order that the reader may judge of both methods and conclusions.

The book of 257 pages is a résumé of a series of tests applied by the author to 'Graphologists' as well as lay experimenters (the latter of all ages and degrees of intelligence) as to their ability to determine the sex (first part, 4 chapters, 21 pages), the age (second part, 5 chapters, 15 pages); the intelligence (third part, 11 chapters, 124 pages); and the character (fourth part, 7 chapters, 77 pages); of a writer by his or her chirography.

Part I.: By what marks can sex be determined in writing?

Dr. Binet proceeds on the ground that if those professing to be graphologists can determine the sex from writing in more than 50 per cent. of cases it raises their ability above that of pure chance, which (*in a large series*) is just 50 per cent.

To avoid suggestion he decided to use the addresses on envelopes. Even here the percentage of error of his experts rises materially when the addresses are from a person of one sex to one of another. The two experts were M. Crépieux-Jamin, of Rouen, and M. Eloy, of Paris.

Amusing experiments to ascertain how much more reliable were professional graphologists than 'ignorants' (those ignorant of the so-called art of 'graphology') resulted as follows. In 180 addresses M. Crépieux-Jamin, by far the most skillful graphologist, was correct in 78.8 per cent. of the cases. He divided his determinations into 'certain' and 'probable.' Of the former were 129 and of the latter 51, that is, he was uncertain twice in seven times. Of his fifty-one mistakes he had marked 28 'certain' and 23 'probable,' while of the 129 correct replies he had marked but 27 replies 'probable' and 102 'certain.'

Those ignorant of graphology gave nearly as great a proportion of correct answers. For instance, a studious girl of seventeen was correct in 70 per cent. of her replies. Four instructors and instructresses in the schools of France reached percentages of 72.9, 73, 73 and 73, though quite ignorant of graphology.

The author concludes with astonishing seriousness, "The gift of recognizing sexual character in writing belongs to nearly everybody, but the ablest of the 'ignorants' are still below the best graphologists"—(by less than 2 per cent. *P. F.*).

Chapter III. is devoted to photo-reproductions of addresses of which some specimens revealed the sex of the writer to all who examined them (18); others were doubtful; and still others were purposely falsified. One

written by a young girl of eighteen was characterized by M. Crépieux-Jamin as 'Certainly a man of thirty or perhaps less.' Another address written by a woman was ascribed by M. Crépieux-Jamin and by M. Eloy to a man. Dr. Binet considers sexual character in writing demonstrated in the most satisfactory manner. The percentage of error of graphologists in determining sex amounts in the most favorable cases to 10 per cent., slightly less than that of the 'ignorants.' Whether this kind of expert evidence may be used in courts he thinks depends upon the answer to the question 'Is a probable error of one tenth admissible in court expert-evidence?'

In any case, he thinks the judges should not admit the testimony of any expert unless he prove by tests that he is one.

Part II.: By what marks can age be determined from handwriting.

M. Crépieux-Jamin, after explaining that it is the physiological and not the actual age which may be deduced, gives four periods which may be distinguished, viz., youth, adolescence, young, and old adults.

In youth the lines are coarse, slow, clumsy and wanting grace; the letters differentiated by increased height.

Adolescents have more expansive and pretentious lines, many inequalities, among others the round of the 'd' turned in. The strokes are firm, distinct and have lost the heaviness mentioned of the very young.

Young adults have a still clearer handwriting, freed from calligraphic forms. Originality of character is evident. Diversity is greater than with adolescents. Each is individual.

Aged adults no longer have the lightness and freshness of line of twenty-five years. Their writing shows lines, thickened angles, marks of hesitation and depressions, *i. e.*, all the graphological indications of diminution of activity.

The following table gives the percentage of errors in the answers of M. Crépieux-Jamin compared with the percentage of errors where the determinations had been made by pure chance. This comparison is made for five separate age-periods.

Number of Errors.	Crépieux-Jamin, Per Cent.	Pure Chance, Per Cent.
Under 6 years.....	34.6	18
From 6 to 10 years.....	26	20
From 11 to 15 years.....	10	26
From 16 to 23 years.....	8	26
From 24 upwards.....	12	28

Dr. Binet concludes that his experiments support the theory of *intuitive* but not *deductive* graphology in the determination of age.

Part III.

Chapter X.: Intelligence in Handwriting.

This determination is thought of greater value than the others. The following graphologists were consulted: MM. Crépieux-Jamin, Eloy, Humbert, Vié, Paulhan, Mmes. Forichon, Ungern-Steinberg and de Salberg. Dr. Binet thinks the probable errors are: (1) uncertainty of establishing the real degree of intelligence of people; (2) suggestions received from the contents of the letters; (3) recognition of some handwritings. Regarding the difficulty of determining an actual order of superiority, twenty-seven names were selected, amongst which were those of Jules Simon, Victorien Sardou, Paul Bert, Renan, Claude Bernard, Alexandre Dumas fils, Dumas (chimiste), Poincaré, Brown-Sequard, Charcot, Brunetière, Lemaitre. The second series (people of average intelligence) had to be selected with great discretion.

He eliminated from consideration those who can not write fluently; the partially and completely illiterate (especially servants); merchants, manufacturers, employees and others whose occupations require legibility and induce calligraphy, that hardest test of graphology. Thus, seven tenths of all the writers in France are excluded by these eliminations.

The two methods of experimenting were: (1) by couples; each couple containing the writing of a great, and of an average intelligence; (2) by two groups of writings, 'A' and 'B.' In 'A' 33 great were mixed with four very narrow intelligences known to Dr.

Binet. In 'B' a large number of mediocrities were mingled with Renan, Cl. Bernard and Daudet. Several experts were selected to sort these names. Average intelligence was classed from 30 to 40; talent, 40 to 50; genius 50 to 60; and the inferior grades, 1 to 30.

To avoid suggestion from the contents of a letter, envelopes were first employed; but the experts objected to the insufficiency of the material "*and their efforts were not brilliant.* In 80 replies but 61 per cent. were correct."

Dr. Binet then had recourse to personal letters, but in cutting out the signature and significant words the meaning was made obscure. (The fact that a letter was thus mutilated would stamp it as of the superior class. *P. F.*)

Another error was in the recognition of the handwriting by the expert; thus: Mme. Ungern Steinberg recognized Zola's writing.

Dr. Binet submitted to each expert a list of 100 known authors and asked if he knew the handwriting of any of them.

Chapter XII.: How is intelligence revealed in handwriting?

M. Crépieux-Jamin recognizes six degrees. Genius, talent, alert intelligence, mediocrity, insignificance and low intelligence. There are pen-strokes characteristic of each of these classes.

Genius manifests itself by power, clearness, simplicity and activity. The strokes are not of common form, but elegant, or well defined, with inequalities not discordant.

Talent has the same signs, with less clearness, simplicity and activity. The signs of cultivation (modifications of the ordinary forms of writing as abbreviations or simplifications) are as numerous as with genius.

Alert Intelligence.—Clear and Simple. Unevenness (index of intellectual sensibility without discordances) is great and gives the impression of a shudder of the pen. Precision not so great as with genius. There appear indications, absent from genius, of cunning, deception, versatility (*sic*), and violence, though not allied with each other.

Mediocrity.—Signs of incompleteness, gaps and discordances. The characters labored or verging upon vulgarity. Marks of meanness, of clumsiness, exaggerations and inequality of the strokes, lack of harmony, lack of clearness, few and not characteristic signs of culture.

Insignificance.—Infantile simplicity of the strokes, lack of energy, activity and signs of culture; even and monotonous with the spaces often exaggerated.

Low Intelligence.—Vulgar, confused and exaggerated forms without marks of culture.

M. Paulhan does not believe in the constant value of even general signs. It is the 'ensemble' of the writing. M. Vié prepared a table expressing 57 different kinds of writing with their respective significations, but other graphologists criticized the table, and M. Crépieux-Jamin refused to use it.

Chapter XIII.: A general glance at the solutions.

A table of the 35 pairs of writings representing intelligence and mediocrity are given with the grades assigned by Crépieux-Jamin, Vié and Paulhan. In the 35 cases Crépieux-Jamin gave 32 correct and 3 incorrect replies; Humbert, 28 correct, 5 incorrect and 2 doubtful replies; Vié, 29 correct and 6 incorrect replies; Paulhan, 26 correct and 9 incorrect replies.

This is the author's summary of the conclusions of the graphologists on the coupled writings. Seven experts gave answers. The majority of them were correct 32 out of 36 times. In ten cases all seven were unanimous and right. In three cases the majority were wrong. Taking the average of all as that of an exceptionally good expert, his average of success would have been 90 per cent. Writing, therefore, reveals unequally the intelligence of the writer. Graphic signs of intelligence are incontestable but are not found in the writing of *all* great intelligences. In this the case resembles physiognomies.

Chapter XV. Portraits. Successful and unsuccessful.

Dr. Binet says: "Reading a series of graphologists' opinions, one is alternately charmed by their accuracy and disgusted by their errors. One can not decide whether or not there

. . . truth in graph[illegible] except by taking the [illegible] of these efforts, which (he thinks) answers the doubt affirmatively."

Madame [illegible] Steinberg graphologizes [illegible] (great mathematician) as 'cultivated, supple, destitute of great delicacy or clear view of things.' Dumas chemist (secretary of the Institut). "Mediocre intelligence, bound to routine, considerable faculties of succeeding, limited horizon. Sees nothing outside of his window pane." Köllicker (great German naturalist), "Mediocre mind, not clear, credulous and suspicious. Discouraged and deceitful. By a transparent ruse he seeks to compensate lack of judgment," etc.

Brown-Sequard.—"Intelligence below average, destitute of clearness and moderation. Impressionable imagination to the prejudice of judgment. Originally intelligence more alert than cultivated. Sum total, muddled mind" (!).

Ernest Rénan.—"Intelligence mediocre and little cultivated (!). Little reflection (!). Credulity, and babbling emphasized. The latter owing to commencing senility."

Crépieux-Jamin says of Rénan's writing: "Clear, delicate and fine mind without attaining talent" (*i. e.*, 38; talent begins at 40 of the scale). Eloy says of the same: "Good average intelligence, some deficiency of reflection but very active. What a good heart!" (He rated another letter of Rénan's similarly.)

Chapter XVI.: Shows the traps Dr. Binet laid for the graphologists.

Crépieux-Jamin, Paulhan and two others were chosen. To these four Dr. Binet sent a lying letter to say that in certain couples they had been completely misled. Among the couples of which this was falsely asserted were two where errors had really been made. Crépieux-Jamin recognized these and corrected them, but he refused to change his judgment of the mental superiority of Rénan to a small provincial lawyer, even when *falsely* told he was wrong; but on the contrary, raised the index of Rénan and lowered that of the other. He did the same when asked to reexamine the writing of Paul Bert and an unnamed official, which he had already rated 42 and 35. He retained the 35 and raised 42 to 47. "This experiment argues well for graphology," says Dr. Binet.

The others fell into the trap and recanted all they had said. Binet apologizes for lying to them, but says he did not transcend his rights as an experimenter.

His conclusion is that "*graphological reasoning may establish two diametrically opposite conclusions*—like politics and other things. It is to be desired that the reasons for opinion were less open to suggestion and more subject to proof."

Chapter XVII.: Necessity of better defining graphological terms.

Graphologists disagree: (1) by finding different 'signs'; (2) by giving different interpretations to what they find. Crépieux-Jamin says: 'Large writing—imaginative.' Paulhan says: 'Large writing—clumsiness.' Two hypotheses are suggested: (1) Graphology is an intuition, can not be explained or controlled; (2) (which is Crépieux-Jamin's view) it is based upon observation of forms, but these (may) neutralize each other.

Chapter XIX.: The achievements of those ignorant of graphology.

Experiments in judging intelligence from handwriting were made with male and female scholars in the primary schools. The masters and mistresses in four communal schools selected ten of the brightest and ten of the dullest scholars between twelve and fourteen.

The 80 envelopes, containing addresses dictated to the scholars, were submitted to 16 persons; 3 of professions, and 13 instructors and instructresses. The majority of the replies agreed with the rating of the instructors in 57, and differed in 20 cases. In 5 the agreement was unanimous; in 6 it was 17 to 1; in 10, 17 to 2. Asked to define the features on which they relied for the opinions, the most frequent replies were: (9) Place and disposition of words, specification, disposition of the address. (9) Accuracy or clumsiness, precision, decision, firmness, energy of the characters. The author asks if these were their real reasons for judging, adding, 'to judge is

one thing and to give reasons for the judgment another.'

The graphologists who tried these same documents only succeeded in 60 to 65.5 per cent. (The 'ignorants' averaged 64.4 per cent. of correct answers practically the same. *P. F.*)

In submitting to 'ignorants' a group of writings from distinguished and from mediocre intelligences the answers were 78 right and 79 wrong, *i. e.*, pure chance. "In fact, how," says Dr. Binet, "is one not endowed with intelligence to discover it in the writing of another" (!).

Chapter XX.: Conclusions.

The signs that indicate age and sex are not constant. The 'ignorant' can comprehend these signs, but less well than the graphologists (by about 0.05 per cent., *P. F.*). The same is the case with intelligence. Dr. Binet's conclusion is: "It is *possible* for graphologists (1) to read intelligence (2) in hand-writing. (1) That is, *some* graphologists. Graphology is not to be confounded with graphologists. Had we not employed Crépieux-Jamin, Vié and Humbert the conclusion as to graphology would have been more severe. (2) Certain intelligences are more revealed than others. The degree of intelligence, genius and talent is hard to determine."

'In short *there is some truth in graphology* but the graphologist's method is not infallible' (and is not sufficiently explained to give it a place as a science. *P. F.*).

Part IV.: Character in Handwriting.

Chapter XXII.: Experiment with the writing of criminals.

Fourteen honest people and eleven criminals contributed the writing studied. The experts were Crépieux-Jamin, Vié, Eloy, Paulhan, Varinard and Mme. de Salberg.

Chapter XXV.: A gallery of murderers and their writing.

Vidal.—Assassin of women. (His portrait is excessively made and repulsive. *P. F.*)

Eight lines of an autobiography written by him in prison. From details of his life Binet portrays him as cunning, cowardly, hypocritical, vindictive, boastful, lazy, violent, with low intelligence. The following diagnoses of character in handwriting are given with fullness in the translated words of the writers because it is the fairest test of the claims of graphology. The words in parentheses refer to the writing, the others to the writer.

Crépieux-Jamin says: "Vivid imagination without grace (inequalites in direction and size, faulty capitals, backhand, large discordant movements, letters too high) associated with an activity of a low order in which agitation (unevenness in size and direction, etc.), discontinuity (bond of junction of words and syllables retarding movement), mediocre (vulgar without relief) and superficial (hesitating, rounded, without relief). He deceives and procrastinates (uneven size, discordant spacing), purpose behind his expansiveness (back handed and sober with large discordant movements). Lying; from too much imagination, is habitual (very uneven size and direction, sinuous and hesitating, too much raised). Lacks reliability (very uneven size and direction, without relief). Not generous (backhand and studied soberness), not good (backhand, turning left, letters too high), but selfish. Proud (too high), not incapable, accidentally, of heroism. Feeble energy ('t's' feebly crossed if at all, hesitating, slow and uneven). Inconsistent. Gentle and violent (curves with many discordances), sensual and lazy (thick letters, heavy strokes). A nature unbalanced."

Dr. Binet praises the portrait but thinks it does not go far enough.

Vié says of this same specimen: "The writing is of a young girl (?) of temperate character (!). Principal characteristic not sentimentality, though she is capable of affection, and of altruism (?) but her emotions are controlled. Has sang froid and is mistress of herself. Principal desire is to please, (?) natural to her elevated tastes (!). She does not exaggerate modesty, but her pride is subjective, for her simple manner does not abandon her in her conduct of her life. She is timid, her lack of impulse does not permit her frankness to follow its natural course but obliges it to recur to diplomacy.

'Moderation' is her motto (?!). Her mind is clear, assimilative, of prompt conception and practical tendency. She has appreciable but not subtle delicacy (!!). Reflection, attention, notable care in seeking the best, (!) speak in favor of her judgment. Imagination not without grace, but large rather than high. What is most surprising is that her intelligence, diffuse in most young girls, is distinguished by concise and very condensed sobriety (!?). Her will shows gaps. In harmony with the timidity already noted she lacks impulse, but has tenacity and firmness in resistance. Her activity has a quality better than will power, balanced as she is in perseverance. Thus appears this young community of tendencies well disciplined under the unity of their rule—moderation (!?).

Eloy: Great impulsiveness. Nature nervous and susceptible. Effort to mark it shows his tenderness of heart, * * * delicate nature * * *. Natural instincts for development, * * * esthetic aptitude give a charm * * *. Is very young * * * sequence of ideas, good logic, good power of assimilation * * * sensitive nature * * *.

He adds with naïveté: "I have felt almost from the beginning of the examination of the eight lines that they were written by M. A. Binet at fifteen to eighteen years. After finishing the study this idea remains. Is this the fact? If so I am ready to give my reasons"(!). Dr. Binet says he is not flattered at this achievement of graphology.

Mme. X.: "Altruism trickles out of the writing. Nevertheless, the writer is not entirely good. Little scratches very feline at the extremities of the strokes and many sharp points show unusual taste for criticism. In spite of his great intelligence (!?), etc., * * *. Heart better than ideas and character. Not violent but usually irritable. Nervous-bilious, with health rather resistant than strong. This reflecting, observing man, without hampering bonds, had great aptitude for administration and organization. Both economical and able. Without being a visionary he was original. Much talent but not genius—like Taine (!?). In any case he was a *thinker* (!?).

Carron.—Parricide (killed his mother by blows of a shoemaker's pliers and a hammer. Jested of her agony before the magistrate).

Crépieux-Jamin: "Selfish. Very reserved (turning to the left), yet affectionate (inclined and uneven in size and direction). Active (rapid), but negligent (light 't's' not crossed), profoundly sensitive (very uneven). These qualities joined to a fund of gentleness (!) and even timidity (curved, rapid and expressive, without relief, with uncrossed 't's' and terminals restrained and fine). Passionate, unhappy and restless (very uneven agitated, uncoordinated, light). Not a bad man (?!). Has tender feelings (!), but his kindness not expansive, but depends on exalted judgment. Rectitude very complicated, not impeccable. He has a conscience and bursts of loyalty (natural and simple, words increasing in size). Little energy (no relief, 't's' unequally or not at all crossed). Judgment mediocre and not sure of results. Don't inspire confidence because qualities insufficient on one side. Frankness combats timidity. Great elasticity of reserve. First impulse often right, second less sincere and more expansive (enlarging, natural, simple, clear, but turning left). Reflection reduces these qualities. After all, he has attractive sides because of his alert adaptive intelligence and his emotional nature" (!).

M. Vié says of the same specimen: * * * "The writing (of Carron *P. F.*) is young and feminine, whence the conclusion that a young girl wrote it. Pleasantly airy, but commonplace from lack of relief. The labored effort shows breaks not consistent with a careful person. Some pleasing delicacies. These little shades diminish in regarding other moral qualities of this young girl, gentle, (!) modest, (!) and not coquettish (!). Moderately expansive, she enhances her reserve by frankness and naturalness. Very sensitive, but her emotions do not long disturb the serenity of her soul. Of loving nature, she possesses a guarded affection, * * * for her moderated imagination does not rest on the blue clouds in which the dreams of young girls often delight. Her activity is

fragile and can not be put to a rude test. She is imperfectly seconded by will power, but tenacious of truth (!). Very apt to attach herself to the object if it comes to her, but will not seek it" (!).

Rachel Galtié.—Poisoner. Killed husband, grandmother and loving brother.

Crépieux-Jamin: "Imagination (large pen movements)? dominates. Mediocre intelligence (graphic discordance, very vulgar and disordered). Lacks judgment and attention. Impulsive, exalted (excessive right and left turns. Words increasing in size), inconsistent (graphic discordances), disordered (disordered and agitated), negligent (uncrossed 't's,' disordered). Like most of those deficient, tries to fill gaps by pretention (ornamental, rolled 'd's,' overheightened). Liar from imagination and disorder (agitated, discordance, 't's' not crossed, right and left turns). Nevertheless, not bad (words increasing in size, small unevenness of direction, curved and clear). Dangerous because passionate and ill-fitted for life (uncrossed 't's' non-coordination of graphic movements) * * * affectionate (inclined, curved with many right-turn movements). Grateful (!) with excess of demonstrations of her very emotional and open (!) nature (very unequal in size—words enlarging—agitated). Has disagreeable rather than odious (?) sides."

The above are selected as samples.

Chapter XXVI.: Measure of individuality.

The author says disagreements of graphologists prove nothing. They disagree just as physicians disagree at the bedside of a patient. Crépieux-Jamin, as the best, is assumed to represent graphology. Of seven portraits he failed in four and succeeded in three. The writings of a batch of really high characters were submitted to him. He was asked to arrange the twenty-two good and criminal in four series of good, medium, wanting and inferior. In the first class he put one good. In the second three murderers and two good. In the third class one murderer and five good. In the fourth seven murderers and two good—dividing the names into two classes, he has seven good and four criminals in the first—four good and seven criminals in the second.

Arranging the names in couples of one good and one criminal and asking his judgment as to their comparison with each other he was right in eight and wrong in three.

Vié and Eloy erred five times in eleven in the same experiment.

Dr. Binet says the graphologists agreed in nine out of twenty-two cases. They can not decide character as well as they can intelligence, and it is uncertain if they ever will.

Chapter XXVII.: General conclusions by Dr. Binet.

"The principal end is less to ascertain whether intelligence and character can be learned from writing, than to point the path to follow in demonstrating moral phenomena. *Probably there is some truth in graphology,* cephalometry (phrenology) and chiromancy."

"The most dangerous foe to experiment is suggestion, 'the cholera of psychology,' * * * after the malice of chance. There are answers given by chance which have such a form as to fall out almost always right * * *. Calculation of chance is not alone the province of the mathematician but of the psychologist. * * * The determination of graphologists is always superior to chance and yet not infallible * * *."

"Graphological signs seem to be elastic enough to fit the most contradictory cases."

"The fault lies not in the signs but in the significations assigned to them."

"Graphology is respected more highly by the public because it is mysterious and incomprehensible."

"It is intuitive. One does not reason, one affirms, and *one only affirms with insistence what is doubtful.* * * * If the client is satisfied the performance is said to have succeeded. * * * Yet science in disdaining graphology neglects a domain vaster than one thinks. It stretches beyond the view, and contains all the empiric knowledge which is of such use to us daily, such as characters of men, prevision of their acts, and sentiments, merely from the sound of the voice, etc. When science invades this domain the present priests of half-light will flee to the realms of the

vague, undetermined, dreams and faith. I offer to collaborate with, say, M. Crépieux-Jamin."

"Graphology is an art of the future."

With slight modification one can agree with Dr. Binet in his conclusions.

There is unquestionably a trace of the man left in every act he performs, but the trace left in writing has not been shown to be a better guide to a knowledge of the sex of the writer than a footprint; of the age than a view of the garments; of the intelligence than the weight of the brain; nor of the character than the appearance of his umbrella. It is not within the power of true science to say that such and such can never be attained, but so far as graphology is concerned we may cite the experiments of its greatest investigator to prove that as yet it has furnished no reliable means of attaining to a knowledge of sex, age, intelligence or character from handwriting.

PERSIFOR FRAZER.
PHILADELPHIA, September, 1906.

Genera Avium. Edited by P. WYTSMAN. 4to. Brussels: V. Verteneuil and L. Desmet. Part I., Passeres—Fam. Eurylæmidæ. By Ernst Hartert. 1905 (1904). Pp. 8; pl. I. Part II., Picariæ—Fam. Todidæ. By P. Wytsman. 1905. Pp. 4; pl. I. Part III., Psittaci—Fam. Stringopidæ. By T. Salvadori. 1905. Pp. 2; pl. I. Part IV., Psittaci—Fam. Nestoridæ. By T. Salvadori. 1905. Pp. 3; pl. I. Part V., Psittaci—Fam. Cacatuidæ. By T. Salvadori. 1905. Pp. 7; pls. II.

The first five parts of this important work, which is intended to include the birds of the world, are all that have appeared up to the present time. All bear the date 1905, though part one was issued also as a sample number during the first half of 1904. Each part is separately paged and contains but a single family. The introductory portion consists of a short historical account of the group treated, its anatomical characters, general habits, range and bibliography. Then follows a key to the subfamilies, if there are any, succeeded by a systematic treatment of the subfamilies, genera and species. Under each subfamily there is a key to its genera; while for each genus are given brief synonymy, generic characters, geographical distribution, a key to the species and a list of species with geographical distribution and a little, often incomplete, synonymy.

The Eurylæmidæ—more properly Eurylaimidæ—(part I.) are divided by Dr. Hartert into two subfamilies—Calyptomeninæ and Eurylæminæ—the first consisting of a single genus with three species, the second of six genera. One form, *Psarisomus dalhousiæ borneensis,* from the mountains of northwestern Borneo, is described as new. The accompanying plate represents the heads of several species. The general treatment of this group is very satisfactory, but we are not quite sure that all the forms treated as subspecies are not in reality distinct, though, of course, closely allied species. More careful proofreading, moreover, would have avoided several very unfortunate errors in scientific names.

The Todidæ (part II.), a family restricted to the Greater Antilles, comprise but a single genus, of which four forms are recognized here. *Todus pulcherrimus* Sharpe is treated as a synonym of *T. hypochondriacus,* and apparently with reason; but we are not at all satisfied that the four admitted forms are merely subspecies, as our author thinks. All are represented on the accompanying plate.

The New Zealand family Stringopidæ—or, as it should be spelled, Strigopidæ—(part III.) has only a single genus of two species, one of which is doubtful—probably but an individual aberration. The plate illustrates various details of *Strigops habroptilus,* including the head of an interesting xanthochroic variety.

Of the New Zealand family Nestoridæ (part IV.) six species, all in the genus *Nestor,* are admitted, but two of these are doubtfully valid, and one is extinct. Four of the forms appear on the single plate.

The Cacatuidæ (cockatoos) (part V.) are divided into two sub-families—Cacatuinæ and Calopsittacinæ. The first is composed of six genera, including provisionally Newton's curious *Lophopsittacus* from Mauritius. In *Ca-*

catua, the largest genus, fourteen species are recognized, and four additional subspecies are casually mentioned, although the latter seem worthy of a more prominent place. The second subfamily contains only the single species *Calopsittacus nōvæhollandiæ.* The two plates depict nine species.

Altogether, these first five parts of 'Genera Avium' are very creditable. The arrangement is good, the exposition clear, and while not so ample as some might wish, is yet probably sufficient for the purpose of the publication. The letter press is quite attractive in appearance; and the plates, all of which are colored, are excellent. This work will prove very useful to all who wish to keep abreast of the times, and will be well-nigh indispensable to the working ornithologist.

HARRY C. OBERHOLSER.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Journal of Science for October contains the following articles:

A. L. DAY AND E. S. SHEPHERD: 'Lime-Silica Series of Minerals,' with optical study by F. E. Wright.

O. C. FARRINGTON: "Analysis of 'Iron Shale' from Coon Mountain, Ariz."

N. T. BACON: 'Phenomena Observed in Crookes' Tubes.'

I. BOWMAN: 'Northward Extension of the Atlantic Preglacial Deposits.'

H. C. BRADLEY: 'A Delicate Color Reaction for Copper, and a Microchemical Test for Zinc.'

A. HILEMAN: 'Elimination and Alkalimetric Estimation of Silicon Fluoride in the Analysis of Fluorides.'

C. BARUS: 'Note on the Actual Drop of Pressure in the Fog Chamber.'

C. BARUS: 'New Method for Standardizing the Coronas of Cloudy Condensation.'

DISCUSSION AND CORRESPONDENCE.

STEPHENS'S CALIFORNIA MAMMALS.

IN no part of the world is the effect of segregation and isolation as a factor in species-forming more evident than in California. No other state of our union offers such diversities of physical conditions, or such a variety of barriers to the dispersion of animals. A faunal map of California has been compared to a crazy quilt, because any such map must recognize the limiting and modifying effects of the different sets of environment connected with the hills, valleys, mountains, lakes and streams of this varied land.

Because of the varying degrees of segregation produced by barriers of mountain and climate, the non-migratory animals of California are especially numerous in species, and many of the recognized species are broken up into numerous subspecies. Each form finds its nearest ally farther on, across the range; and, again, types once differentiated may invade each other's territory, when conditions enable individuals to cross the border.

In a volume called 'California Mammals' (West Coast Publishing Company, San Diego), Mr. Frank Stephens, of San Diego, has brought together compact descriptions of all the mammals thus far recorded from California. The descriptions are carefully written, the accounts of habits are full and accurate, the volume is well printed, and it can not fail to be of great value to the students of California beasts. Two hundred and seventy-six species and subspecies are included in the list. The volume contains also an excellent essay on the 'Life Areas of California.' Under the head of *Homo sapiens americanus,* the most specialized of the indigenous mammals of California, is given a map showing the distribution of the twenty-one linguistic stocks.

DAVID STARR JORDAN.

AN IGNORED THEORY OF THE ICE AGE.

LOOKING over the recently issued work on 'Geology' by Professors Chamberlin and Salisbury, I was surprised and disappointed to learn that in this voluminous publication of nearly two thousand pages, many of which are devoted to considerations of causes leading up to the ice age, the name of Dr. Marsden Manson is not to be found.

In a work like this, designed for the use of students and general readers, views antagonistic to generally accepted dogmas and pet theories, should, when endorsed by recognized authority, find fair treatment.

Manson's theory of the ice age has been favorably received by some eminent geologists. Thirteen years ago, shortly after Manson's memoir entitled 'Geological and Solar Climates' was first published, I wrote,[1] from an astronomer's point of view, as follows:

Under the above title Dr. Marsden Manson has published a thesis, issued by the University of California, of more than ordinary merit. Geologists tell us that large areas of now densely populated regions of the earth were at one time covered with ice to a depth of many feet. To most scientists the explanations hitherto given, to account for the cause of the so-called *Glacial Epoch*, seem wholly inadequate. Dr. Manson's treatment of the problem is unique, and to many it will appear quite convincing. We do not hesitate to recommend it for careful study to those interested in astro-geological physics.

I now copy, word for word, the last paragraph of a recent paper entitled 'The Causes of the Glacial Epoch,' written by a recognized leader in science. He concludes as follows:

It does seem to the writer that unless it can be shown that the temperature prevailing at the beginning of the glacial epoch could not have been high enough to maintain a cloud envelope, Manson's theory as outlined above must be considered as the most probable among those that have heretofore been suggested, as fulfilling both qualitatively and quantitatively the postulates of the great Ice Age; not excluding of course the probable influence of the agencies claimed by Arrhenius and Chamberlin as the chief ones, but which appear to the writer to be inadequate to account for the phenomena in actual evidence.

Such is the testimony of a geologist of world-wide fame.

J. M. Schaeberle.

Ann Arbor,
August 30, 1906.

[1] See No. 32, 'Publications of the Astronomical Society of the Pacific.'

Non-Euclidean Geometry.

To the Editor of Science: My attention has been called to some quotations from a private letter of mine in an article by Professor George Bruce Halsted on 'The Value of the Non-Euclidean Geometry,' which appeared in the November number of the *Popular Science Monthly*, 1905. The letter referred to was written by me to the author in answer to a query of his of March 21, 1904, couched in the following words:

I am *curious* to know, if in the face of such a statement as Poincaré's in his review of Hilbert, 'The postulate of Euclid then can not be demonstrated; and this impossibility is as certain as any mathematical truth whatsoever,' you actually still think that you have proved it, or that you have proved that external space is necessarily Euclidean.

In view of the fact that the quotations do not adequately express my views, I beg you for the privilege of being granted some of your valuable space for the publication of my letter in full. The true copy of my letter dated March 25, 1904, follows. The quotations are enclosed in brackets:

My dear Professor Halsted—Your letter of the 21st inst. has just reached me. From its tone I conclude that you are in earnest about the matter, and I am glad to have found in you a man who intends to read the work. The dissertation was written for the purpose of bringing before the mathematical world certain contentions—no matter how seemingly heterodox—for which a scientific basis is claimed to have been laid down in the new treatment and in the new point of view; and, of course, if the claim is not well established, then either the treatment or the point of view is open to criticism—and *fair criticism*, whether favorable, or *unfavorable*, is cordially invited, even solicited. [As to Poincaré's assertion about the impossibility of proving[1] the Euclidian postulate, it is no more than a belief—though an enthusiastic one—never proved mathematically, and in its very nature incapable of mathematical proof,] unless we are certain that space is non-Euclidian. [Poincaré is undoubtedly a great mathematician, perhaps the greatest now living; but his assertion of his inmost conviction, no matter how strongly put, can not pass for mathematical truth, unless *mathematically* proved. His conclusion—shared also by many another noted mathematician, as well as by the founders of the non-Euclidian geometries—can only be based on the fact of the existence of these last geometries, self-consistent and perfectly log-

[1] I stand corrected with regard to the germanisms, 'impossibility to prove,' 'impossibility to establish,' which appeared in the original text of the letter.

ical. But this is a poor proof of the impossibility of establishing[1] the Euclidian postulate,] since the non-Euclidian systems have to deal with a different class of phenomena; such are the metrical relations upon the sphere and the pseudosphere in two-dimensional point-space, and those holding in three-dimensional curved manifolds contained in n-dimensional space, or in space whose element is changed from that of a point in the ordinary Euclidian sense to some other geometrical entity depending on n coordinates, like Plücker's four-dimensional line-space. I should refer you for the elucidation of this point of view to pp. 27–32 of the dissertation, especially to p. 29 and sequel, where a quotation from Bianchi is discussed and refuted.

The difference between my position and yours is, it seems, as follows: while you maintain that external space is either Euclidian or non-Euclidian, and there is no possibility of ever finding out which, for the Euclidian postulate can neither be proved nor disproved, I assert that external space is both Euclidian and non-Euclidian, according to the point of view. [If space is regarded as a point-manifold, it is Euclidian, and the postulate can be proved, as soon as we are allowed to look for its establishment in three-dimensional geometry,] of which two-dimensional geometry is only a part. If space, however, is regarded as a line-manifold, say, then *certain* two- and three-dimensional manifolds contained in it are non-Euclidian. So, for instance, all lines passing through a point represent [the two-dimensional elliptic geometry discussed by Klein, Lindemann and Killing], which, [according to my opinion, is an absurdity for a point-space in the ordinary sense of the term]. As to [Poincaré], he seems to stand on a very similar basis—namely, in that he does not oppose the non-Euclidian to the Euclidian geometry and [says that all depends upon convention] as to what we understand by distance, straight line, angle, etc. [But still he deduces from this the perfectly gratuitous conclusion that therefore the parallel-postulate can not be proved.] It is gratuitous, according to my opinion, because, as the simultaneous existence of both the Euclidian and the non-Euclidian groups of motion have been proved beyond a shadow of doubt, they must evidently refer to different classes of phenomena, and hence there must exist a Euclidian space and a non-Euclidian space. And as the actual space is only one, all must depend upon the point of view (the entity taken as the space element). Therefore, for point-space the postulate may be a necessity, without involving its necessity for other three-dimensional manifolds, like certain line-complexes, for instance,—just as plane geometry, even if it were admittedly Euclidian, would not have to hold for the geometry of the sphere or the pseudosphere.

You will observe that the groups of motion in Lie's treatment are deduced from the assumption of an *analytical* point, that is some entity depending upon a certain number of coordinates $x_1, x_2, \cdots x_n$, and, evidently, the entity in this case is indeterminate. You may call it point, but it may actually correspond to something quite different from what we understand by this name in *elementary geometry*.

I trust that, according to the maxim that *curiosity* is the mother of all knowledge, the perusal of my treatise, in pursuance of the gratification of this laudable feeling, may change your attitude upon this question, and will convince you that, instead of the different systems of geometry warring with each other, they are actually in peace,—the non-Euclidian systems, however, still needing interpretation in *many particulars*—an interpretation realizable in *our* space, in the space in which all of us live and think and work and strive for perfection.

I. E. RABINOVITCH.

SPECIAL ARTICLES.

INHERITANCE OF COLOR COAT IN SWINE.

MR. Q. I. SIMPSON, the well-known swine breeder of Palmer, Ill., is conducting several series of crosses between different breeds of swine, the breeds thus far used being Tamworth (red), Yorkshire (white), Poland China (black with white points), the wild boar of Europe and Duroc-Jersey (red).

He bred a wild boar to a Tamworth sow, securing a large litter all much resembling the wild boar, having his color, snout, eyes, ears, length and size of legs, tail, shape of body, size, wildness and characteristic movements. From two of these hybrid pigs and a Tamworth boar he has secured three litters, each containing four pigs. What the usual litter of wild pigs is I do not know, but the Tamworth litter is usually eight or more pigs. The body color of these three litters is as follows:

Litter No. 1—3 wild boar's color.
1 Tamworth red.
Litter No. 2—1 wild boar's color.
3 Tamworth reds.
Litter No. 3—2 wild boar's color.
2 Tamworth reds.

The sum of these results agree exactly with the highest Mendelian expectation if we assume the two coat colors to constitute a character pair, the color of the wild boar being dominant.

A cross between a Tamworth boar and a Yorkshire sow resulted in eleven pigs, all alike: hair entirely white; skin dark with white spots, but with a white belt extending entirely around the body at the shoulders, and including the fore legs; face dished like the Yorkshire but with long snout of the Tamworth. One of these hybrids (male) was crossed with a Tamworth colored three fourths Tamworth, one fourth Yorkshire, with the following interesting result:

Representing the body color of the Tamworth by R (r when latent), and that of the white breed by W, the Mendelian formula for this complex breeding would be

$$\left.\begin{matrix} R \\ W \end{matrix}\right\} \left.\begin{matrix} R \\ Wr \end{matrix}\right\} \left\{\begin{matrix} \tfrac{1}{4}R_1 \\ \tfrac{1}{4}Wr \end{matrix}\right. \left.\begin{matrix} Wr_1 \\ \tfrac{1}{4}R_1 \end{matrix}\right\} \left\{\begin{matrix} \tfrac{1}{8}Wr \\ \tfrac{1}{8}R \end{matrix}\right.$$

the R_1 being the three fourths Tamworth, one fourth Yorkshire dam, the Wr_1 being the hybrid Tamworth-Yorkshire sire. To agree with this formula, half the progeny should be white (dominant hybrid) and half red (extracted recessive). There were eight pigs in the litter, four of which were of a rich Tamworth red color, and four with hair light gray tinged with red, white skin with dark patches, and the characteristic white belt of the original hybrids. These results indicate that the red and white coats of these breeds form a character pair, with white dominant, as it is in the Yorkshire-Berkshire and the Yorkshire-Poland China crosses (unpublished results of the writer). They also indicate that the dominant hybrid (Wr) shows traces of recessive characters present, as all the Wr progeny thus far produced show the peculiar white belt of skin color around the body, and (in all but the original Wr litter) have a reddish tinge in the hair color.

The same Wr male was bred to a Poland China sow (black with white points), the formula for which breeding (assuming red dominant over black) would be

$$\left.\begin{matrix} Wr \\ B \end{matrix}\right\} \left\{\begin{matrix} \tfrac{1}{2}Wb \\ \tfrac{1}{2}Rb \end{matrix}\right.$$

This calls for half the progeny white and half red. The actual results were four white or black and white, and five red or black and red. In each case the recessive black appeared to a greater or less extent. Of the four, two were pure white with dark skin, one was black and white spotted, and one was black with white points, like a pure Poland China. In Yorkshire-Berkshire crosses I have found the usually recessive black appearing conspicuously in some Wb individuals, so that these results are explained by assuming incomplete dominance of white. Of the five showing red color, three were nearly pure Tamworth red, having only a few black spots, and two were red and black spotted. This indicates a tendency for red to dominate black, but the dominance varies, and is almost never complete.

One of the above red- and black-spotted boars was bred to three Poland China sows. The formula for this breeding may be written

$$\left.\begin{matrix} R \\ W \end{matrix}\right\} \left.\begin{matrix} Wr \\ B \end{matrix}\right\} \left\{\begin{matrix} \tfrac{1}{2}Wb \\ \tfrac{1}{2}RB \end{matrix}\right. \left.\begin{matrix} \\ B \end{matrix}\right\} \left\{\begin{matrix} \tfrac{1}{2}RB \\ \tfrac{1}{2}B \end{matrix}\right.$$

Remembering that the Poland China black appears either as black and white spotted or black with white points in pure Poland Chinas, we should expect half of each litter to be red and black spotted and half black and white spotted (or black with white points). The results were

	BR Spotted.	*Bl* and *Wh.* Spotted.
Litter No. 1.....	4	4
Litter No. 2.....	3	3
Litter No. 3.....	3	3

All the above results meet the highest Mendelian expectation on the assumptions made regarding character pairs and dominance. We should expect some departure from the highest expectation. In the following we find it.

The same *RB* boar used in the last cross was bred to a one eighth Duroc-Jersey (red-*R'*) seven eighths Poland China sow having perfect Poland China markings. The highest expectation is shown in the formula of this breeding.

$$\left.\begin{matrix} R \\ W \end{matrix}\right\} Wr \left.\begin{matrix} \\ B \end{matrix}\right\} \left\{\begin{matrix} \frac{1}{2}Wb \\ \frac{1}{2}RB \end{matrix}\right\} \left.\begin{matrix} \\ \\ \\ \end{matrix}\right\} \left\{\begin{matrix} \frac{1}{2}RB \\ \frac{1}{2}B \end{matrix}\right.$$

$$\left.\begin{matrix} R' \\ B \end{matrix}\right\} R'B \left.\begin{matrix} \\ B \end{matrix}\right\} \left\{\begin{matrix} \frac{1}{2}R'B \\ \frac{1}{2}B \end{matrix}\right\} B_1$$

The Duroc-Jersey red (*R'*) seems to have been eliminated in the breeding of the dam B_1. Here the highest expectation is that half of the progeny should show red markings; four of them were red and black spotted and two nearly pure red with a few black spots, indicating that they were all of the *RB* type, a case the probability of which in this particular cross is one sixty-fourth.

The above results can not be regarded as conclusive concerning any of the points involved, but they do render it highly probable that there are good Mendelian characters in this class of animals. They are published with the hope of stimulating further enquiry along this line.

W. J. SPILLMAN.
U. S. DEPT. OF AGRICULTURE.

CURRENT NOTES ON METEOROLOGY.

VAGARIES OF LIGHTNING.

A PAPER in the *Quarterly Journal of the Royal Meteorological Society* for July, by Alfred Hands, deals with 'Some So-called Vagaries of Lightning Reproduced Experimentally.' Lightning is an electric charge, the author says, and should act in accordance with the laws that are known to govern discharges. In the course of an extended investigation into the effects of lightning, Mr. Hands has come across many cases that have been called vagaries, but which on close inspection have proved to be extraordinary only in the erroneous way in which they were described. Had they been correctly reported, they would have appeared perfectly consistent with ideas previously held—in fact, they could have been foretold in every case if the conditions that led to those effects had been known before the events occurred.

Mr. Hands reproduced experimentally several so-called vagaries of lightning, showing by means of skeleton models the conditions under which they occurred, and by a single discharge producing effects which would be most perplexing if the arrangement of the hidden links in the alternative path of conduction were not known.

AFRICAN HUTS ON POLES TO ESCAPE MOSQUITOES.

THE placing of native dwellings on poles to elevate them above the ground during overflows in the rainy season has long been known as an interesting illustration of the influence of climate upon architecture. In an account of a journey 'From Mombasa to Khartum: through Uganda and down the Nile,' Sir Charles Eliot notes the use of platforms on poles ten or twelve feet high by some of the native tribes along the Bahr-el-Gebel. These platforms serve as places of repose when mosquitoes are very abundant, for it is found that the mosquitoes do not go far above the ground (*Scot. Geogr. Mag.*, 1906, 350).

PILOT CHARTS.

THE monthly pilot charts of the North Atlantic and North Pacific Oceans, issued by the Hydrographic Office of our Navy, are well known. Five years ago the British Meteorological Office began the publication of monthly North Atlantic pilot charts, and has now undertaken *Monthly Meteorological Charts of the Indian Ocean North of 15° South Latitude, and Red Sea.* The first number is for May, 1906. Two pilot charts are published by the Deutsche Seewarte, at Ham-

burg, one for the North Atlantic and Mediterranean, issued monthly, and one for the North Sea and Baltic, issued quarterly.

NOTES.

An investigation into the Beaufort wind-scale and its relation to measured wind velocities has been made in England, and the results are published in an official report ('Report of the Director of the Meteorological Office upon an Inquiry into the Relation between the Estimates of Wind-Force according to Admiral Beaufort's Scale and the Velocities recorded by Anemometers belonging to the Office,' London, 1906).

R. DeC. Ward.

CEREBRAL LOCALIZATION OF MUSICAL TALENT.

Dr. S. Auerbach has published an interesting contribution[1] to the cerebral localization of the musical talent in a description of the surface morphology of the brain of Professor Naret Koning, late director of the opera in Frankfurt a. M. The report includes a comparative study of the brain of the celebrated composer Hans v. Bülow, for some time in the possession of Professor Edinger, and of brains of other eminent men, of known musical talent, previously described. The author finds in the considerable breadth and configuration of the (supra)marginal gyre, as well as the adjacent portion of the supertemporal gyre, an expression of the greater aptitude for the multitudinous associations in the auditory sphere which distinguished these persons from others less musical. The author goes on to show that the corresponding portions of the skull usually indicate this redundancy.

As has been urged frequently by cerebral morphologists in America, contributions of this kind make it highly desirable to secure for comparison more brains of persons of peculiar aptitudes in various lines of mental activity. Not only the brains, but also the skulls, head-casts and photographs taken in accordance with approved anthropometric methods are needed. The preservation of the brain is requisite not only for macroscopic study, but also for researches in the minute structure of the redundantly developed regions.

Edw. Anthony Spitzka.

[1] *Archiv für Anatomie und Physiologie*, Anatomische Abteilung, 1906, pp. 197–230, Plates XII.–XVII.

GRANTS FOR SCIENTIFIC RESEARCH BY THE BRITISH ASSOCIATION.

At the recent York meeting of the British Association, as we learn from *Nature*, grants of money appropriated for scientific purposes by the general committee were:

	£	s.	d.
Section A—Mathematical and Physical Science.			
Electrical Standards	50	0	0
Seismological Observations	40	0	0
Magnetic Observations at Falmouth	40	0	0
Magnetic Survey of South Africa	25	7	6
Further Tabulation of Bessel Functions	15	0	0
Section B—Chemistry.			
Wave-length Tables of Spectra	10	0	0
Study of Hydro-aromatic Substances	30	0	0
Dynamic Isomerism	30	0	0
Section C—Geology.			
Life Zones in British Carboniferous Rocks	12	7	7
Erratic Blocks	21	16	6
Fossiliferous Drift Deposits	25	19	0
Fauna and Flora of British Trias	10	0	0
Crystalline Rocks of Anglesey	7	18	11
Faunal Succession on the Carboniferous Limestone of S. W. England	15	0	0
Correlation and Age of South African Strata, etc.	10	0	0
Investigation of the Speeton Beds at Knapton	10	0	0
Section D—Zoology.			
Index Animalium	75	0	0
Table at the Zoological Station at Naples	100	0	0
Development of the Frog	5	14	6
Respiratory Phenomena and Color Changes in Animals	11	2	0
Experiments on the Development of the Sexual Cells	5	0	0
Section E—Geography.			
Oscillations of the Land Level in the Mediterranean Basin	50	0	0

	£	s.	d.
Rainfall and Lake and River Discharge.	10	0	0
Section F—Economic Science and Statistics.			
International Trade Statistics.....	15	0	0
Gold Coinage in Circulation in the United Kingdom	10	0	0
Section H—Anthropology.			
Excavations in Crete.....	100	0	0
Glastonbury Lake Village.....	30	0	0
Excavations on Roman Sites in Britain	15	0	0
Anthropometric Investigations.....	17	17	3
Age of Stone Circles.....	3	0	0
Anthropological Photographs.....	3	3	6
Section I—Physiology.			
Metabolism of Individual Tissues.....	45	0	0
The Ductless Glands.....	25	0	0
Effect of Climate upon Health and Disease	55	0	0
Section K—Botany.			
Physiology of Heredity.....	30	0	0
South African Cycads, etc.....	35	0	0
Botanical Photographs.....	5	0	0
Structure of Fossil Plants.....	5	0	0
Peat Moss Deposits.....	7	5	7
Marsh Vegetation	15	0	0
Section L—Educational Science.			
Studies suitable for Elementary Schools	10	0	0
Conditions of Health in Schools.....	5	0	0
Corresponding Societies Committee.			
For Preparation of Report.....	20	0	0
Total	1061	12	4

THE SILLIMAN LECTURES AT YALE UNIVERSITY.

THE Silliman lectures for 1906 will be given in the Sloane Laboratory of Yale University by Professor Walther Nernst, of the University of Berlin, beginning on October 22. The subjects of the twelve lectures are as follows:

1–3. 'General Application of Thermodynamics to Chemistry. The Equation of the Reaction Isochore $Q = RT^2(d \ln K/dT)$.' Monday, October 22; Tuesday, October 23; Wednesday, October 24.

4. 'Integration of this Equation and Preliminary Discussion of the Undetermined Integration Constant.' Thursday, October 25.

5–6. 'The Relation between the Internal and the Free Energies at Very Low Temperatures.' Friday, October 26; Monday, October 29.

7–8. 'Determination and Evaluation of the Integration Constant by means of the Curve of Vapor Pressure.' Tuesday, October 30 (two hours).

9. 'New Experimental Researches on Chemical Equilibrium at High Temperatures.' Wednesday, October 31.

10–12. 'Examples for the Theoretical Calculation of Chemical Equilibrium from the Heat of Reaction: (*a*) Homogeneous Systems; (*b*) Heterogeneous Systems.' Thursday, November 1; Friday, November 2 (two hours).

The Silliman memorial lectures on subjects connected with 'the natural and moral world' were established by the will of Augustus Ely Silliman, of Brooklyn, N. Y. The Mrs. Hepsa Ely Silliman memorial fund, which supports this lectureship, came into the possession of Yale University in 1901. The preceding lecturers have been:

1903. PROFESSOR THOMSON, Cambridge University: 'Electricity and Matter.'

1904. PROFESSOR SHERRINGTON, University of Liverpool: 'Integrative Action of the Nervous System.'

1905. PROFESSOR RUTHERFORD, McGill University: 'Radioactive Transformations.'

HONORARY DEGREES AT HARVARD UNIVERSITY.

AT the academic session held in Sanders Theater on September 26, in connection with the dedication of the new buildings of the Medical School, honorary degrees were conferred by President Eliot in the following words:

In accordance with time-honored university usage on occasions of rejoicing, I now create, in exercise of authority given me by the president and fellows and the board of overseers,

HONORARY DOCTOR OF ARTS.

Charles Allerton Coolidge, architect, designer of admirable buildings for academic and scientific uses in California, Illinois, New York and Massachusetts; designer of the monumental new buildings of the Harvard Medical School, buildings in which are combined spaciousness, splendor of material, fine grouping, durability and careful adaptation to their special uses; through professional skill and patience an influential promoter of the purposes and wishes of the Medical Faculty.

HONORARY DOCTOR OF SCIENCE.

Simon Flexner, born and brought up to the standing of a physician at Louisville, Kentucky, trained as a student and professor of pathology chiefly at the Johns Hopkins University; productive investigator and author in bacteriology and pathology; since 1904 director of the laboratories of the Rockefeller Institute for Medical Research, and there the competent master of great resources for the immediate and constant advancement of Medical Science.

DOCTORS OF LAWS.

John Collins Warren, instructor and professor of surgery in Harvard University for thirty-five years; author, and eminent practitioner in surgery; the enthusiastic, winning and indefatigable promoter of the great undertaking of the Medical School, who knew how to inspire others with his own well-grounded hopefulness and ardor.

Henry Pickering Bowditch, for thirty-five years chief teacher of physiology in Harvard University; for ten years dean of the Medical School; investigator, as well as teacher and administrator; whose imagination conceived, whose faith foresaw the new Medical School, and who contributed to the realization of his vision by diligent labor in the cause and through the confidence which others felt in his foresight and sagacity.

José Ramos, professor of pathology and chief of the clinical staff in the Medical School of Mexico, officer of the Medical Institute of Mexico, senator from the state of San Luis Potosi, in whose welcome presence Harvard University gladly remembers that the University of Mexico was her elder sister on the American continent.

Franz Keibel, professor of anatomy in the University of Freiburg, eminent investigator in anatomy and embryology, worthy representative of German genius for medical research and teaching.

Charles Scott Sherrington, lecturer and professor at the University of London, St. Thomas's Hospital and the University of Liverpool; distinguished experimental physiologist, and especially neurologist; public-spirited and active member of famous scientific societies and serviceable medical organizations.

Francis John Shepherd, professor of anatomy in McGill University; Canadian by birth, education and service; distinguished surgeon; active contributor to professional literature; ready sharer in the public functions of the profession, and in its works of charity and good will.

Sir Thomas Barlow, professor of Clinical Medicine, physician to His Majesty's Household and to University College Hospital; eminent general practitioner and consultant.

Abraham Jacobi, a medical graduate of Bonn University in 1851, and a practising physician in New York since 1853; professor of the diseases of children since 1860; officer in many hospitals and medical societies; productive author; alert, energetic, progressive practitioner; honored medical veteran.

And in the name of this society of scholars I declare that they are entitled to the rights and privileges pertaining to their several degrees, and that their names are to be forever borne on its roll of honorary members.

SCIENTIFIC NOTES AND NEWS.

The University of Aberdeen celebrated last week the four hundredth anniversary of its foundation with some three thousand delegates in attendance. According to a cablegram to the daily papers, the degree of doctor of laws was conferred on 110 of the delegates, including Professor F. W. Clarke, chief chemist of the U. S. Geological Survey; Dr. Arnold Hague, geologist of the U. S. Geological Survey; Dr. J. William White, professor of surgery in the University of Pennsylvania, and Professor Howard A. Kelly, professor of gynecology in the Johns Hopkins University.

Professor E. L. Nichols, of Cornell University, and Professor Wm. T. Sedgwick, of the Massachusetts Institute of Technology, will make the addresses at the formal dedication of the new Eastman science building at Rochester University, which will house the departments of physics and biology. It is expected that the dedication will take place during the month of October.

Sir William Perkin has arrived in this country. As has already been announced, the jubilee of the foundations of the coal-tar industry by the discovery of mauve will be celebrated at a banquet at Delmonico's on Saturday evening. Other entertainments have been arranged for Sir William Perkin, including a smoker at the Chemists' Club, New York City, and a dinner at Boston.

Dr. Charles F. Chandler, professor of chemistry in Columbia University, has re-

ceived from the University of Göttingen a renewal of his degree of doctor of philosophy granted fifty years ago.

DR. GEORGE L. STREETER, instructor in anatomy in the Johns Hopkins University, and Dr. Shinkishi Hatai, assistant in neurology in the University of Chicago, have been added to the staff of the Wistar Institute of Anatomy, Philadelphia.

DR. D. H. CAMPBELL, professor of botany at Stanford University, has returned after an absence of a year. He attended last year the International Botanical Conference in Vienna and the South African meeting of the British Association for the Advancement of Science. He subsequently spent a considerable time in the Botanical Gardens at Peridinia, Ceylon, and Buitenzorg, Java.

DR. N. L. BRITTON, director of the New York Botanical Garden, Mrs. Britton and Professor Lucian M. Underwood, of Columbia University, have spent the past month in Jamaica, where the garden maintains at Chincona a tropical laboratory.

DR. C. B. ROBINSON, assistant curator of the New York Botanical Garden, spent the month of August in Nova Scotia making collections for the garden.

STAFF SURGEON ALEXANDER GASKILL, of the British Royal Navy, is in America studying naval hospital methods.

DR. BRADLEY M. DAVIS will spend next winter in Cambridge, Mass. (17 Felton Hall). His immediate work will be the completion, with Mr. Bergen, of a laboratory and field manual to accompany the 'Principles of Botany,' which has recently appeared from the press of Ginn and Company.

DR. GEORGE BRUCE HALSTED, F.R.A.S., has accepted the headship of the department of mathematics in the State Normal School of Colorado at Greeley. Dr. Halsted's translation of Poincaré's 'The Value of Science' is appearing as a serial in the *Popular Science Monthly*, to be later a companion volume to his 'Science and Hypothesis.'

SIR GEORGE WATT, C.I.E., reporter an economic products to the Indian government, delivered the opening address of the session at the School of Pharmacy of the Pharmaceutical Society of Great Britain, and the president of the society presented the Pereira medal on October 1.

DR. SAMUEL SHELDON gave the presidential address before the American Institute of Electrical Engineers, New York City, on September 28, his subject being 'The Work of the Institute.'

A MEDAL in memory of Fritz Schaudinn, to be awarded every second year for distinguished work in micro-biology, has been established at the Hamburg Institute of Tropical Diseases, with which Schaudinn was connected at the time of his death.

A MONUMENT to Ignaz Semmelweis, the distinguished physician, was unveiled with appropriate ceremonies at Budapest on September 30.

DR. FELIX LEOPOLD OSWALD, the author of numerous books and articles on natural science, born in Belgium in 1845, and recently residing at Grand Rapids, Mich., was killed by a train at Syracuse on September 27.

THE death is announced of Professor H. Cohn, of the University of Breslau, known for his work in ophthalmology.

IT is announced that the German government will hold in Berlin in 1912 an international exposition, which will be planned on a scale surpassing all previous expositions of this character.

IT is reported that the Ontario cabinet is considering the establishment of a department of public health.

AFTER the opening of the Institute of Cancer Research at Heidelberg on September 25, an International Conference on Cancer was held at Frankfort-on-the-Main on September 26 and 27.

IN view of the continuance of the disastrous epidemics of plague, cholera and smallpox, and the heavy perennial mortality from malaria, the government of India has decided to create an entirely new service of sanitary engineers, whose special province it will be to safeguard public health. A committee of experts has

been appointed to consider the details of the scheme.

We learn from *Nature* that the Association des Industriels de France contre les Accidents du Travail intends offering a prize of 8,000 francs for an international competition for a new galvanic battery or accumulator which, while having a large output for its size and weight, must not be dangerous in use. Inquiries should be addressed to the director of the society, rue de Lutèce, Paris, who will supply further particulars, and to whom competitors must send their descriptions and drawings.

The London *Times* reports that at its plenary sitting at Brussels on September 11 the International Polar Exploration Congress voted unanimously for the formation of an international polar commission. The members of the commission are to hold office for six years. Corresponding members may be nominated among men of science and others who have in any way assisted polar exploration. The commission is to elect by vote a president, vice-president and secretary for a term of three years. The commission is forbidden to undertake any operations of a financial nature. Its primary aims are to bring about closer relations among polar explorers, to coordinate scientific observations and to assist polar enterprise, without, however, organizing expeditions on its own account.

UNIVERSITY AND EDUCATIONAL NEWS.

By the death of the sister of the late W. W. Guiteau, Cornell University will receive the legacy left by him, said to amount to between $100,000 and $200,000.

The courts have handed down a decision by which the University of Rochester will receive the $75,000 bequeathed to it by the late Lewis H. Morgan.

The new building for the Atlanta College of Physicians and Surgeons has been erected at a cost of $75,000.

In connection with the celebrations of the fourth centenary of the University of Aberdeen, the new buildings, erected at a cost of $1,250,000, were opened by King Edward.

Augustus Trowbridge, Ph.D. (Berlin), professor of mathematical physics at the University of Wisconsin, has been called to Princeton University. We have already noted the call of Professor O. V. Richardson, of Cambridge University, to a chair of physics at Princeton; Dr. H. L. Cooke, also of Cambridge University, has been called to an assistant professorship of physics.

Dr. C. D. Child, professor of physics at Colgate University, has been appointed to a similar chair in the School of Mining at Kingston, Ont.

Dr. A. Duncan Yokum has been appointed professor of pedagogy in the University of Pennsylvania, to succeed Dr. Martin G. Brumbaugh, who has become superintendent of the Philadelphia public schools.

At Brown University, Dr. Herbert E. Waters, of the University of Chicago, succeeds Dr. Leonard W. Williams as assistant professor of comparative anatomy.

Mr. E. H. Archbold has been appointed associate professor of chemistry in Syracuse University.

At Rochester University, Assistant Professor A. S. Gale has been promoted to a professorship of mathematics and Mr. Howard D. Minchin to an assistant professorship of physics.

Miss Mabel Chase has been promoted to be an associate professor of physics at Mount Holyoke College, and Miss Eleanor C. Doak has been appointed associate professor of mathematics.

Dr. Marion M. Hull has been elected professor of materia medica and therapeutics at the Atlanta School of Medicine, in succession to the late Dr. Charles D. Hurt.

Mr. James Muir, M.A., B.Sc., assistant to the professor of natural philosophy in Glasgow University, has been appointed to the chair of natural philosophy in the Glasgow and West of Scotland Technical College.

Dr. Wilhelm Wien, professor of physics at Würzburg, will succeed to the chair occupied by the late Professor O. Drude.

SCIENCE

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THE FUTURE OF MEDICINE.[1]

THE future occupations and interests of the medical profession are to be in some respects different from those of the past, and they are to be more various. The ordinary physician has for the last hundred years been almost exclusively a man devoted to the treatment of diseases already developed in human bodies or of injuries already incurred. He made his diagnosis, and then sought remedies and a cure. He was the sympathetic and skilful helper of sick or injured persons. Most of the cases that came under his care were cases considered plain as to symptoms, period and accepted treatment. The minority of cases were obscure, and called for unusual knowledge and skill in discerning the seat of the disorder, or the approximate cause of the bodily disturbance. Hence the special value of the experienced consultant, who was ordinarily a man of some peculiar natural gift of body, mind or temperament, possessing also in high degree the faculty of keen observation, and the habit of eliminating irrelevant considerations, and ultimately finding his way to the accurate, limited inference from the facts before him. Both the ordinary physician and the consultant have already been much helped by the extraordinary progress made in medical science during the last thirty years; but they have been helped chiefly to a surer recognition of diseases established in human

[1] An address delivered by President Charles W. Eliot, on September 26, 1906, at the dedication of the Harvard Medical School.

bodies, and to a better treatment of their patients' diseases when recognized.

The physician or surgeon commonly renders a personal service to an individual, sometimes for a pecuniary recompense, but often without money compensation. He is often a trusted adviser in the most intimate family concerns. Births and deaths alike bring the physician into the home. In rendering these services he must be tender, sympathetic, considerate, pure-minded and judicious. There will always be need, crying need, of the physician and surgeon in this sense, and for these functions; and whatever else the regular education of the physician provides in the future, it must provide all the elements of the best training for the practising physician who is to treat diseased or crippled human bodies, and give advice about the sudden and the chronic ills which afflict humanity. So much will continue to be demanded of all good medical schools; but much more they must do.

The progress of what we call civilization exposes human beings more and more to the ravages of disease. When savages come in contact with men called civilized, they invariably suffer from diseases new to them. When a rural population crowds into cities, it falls a victim of diseases from which in the country it had been exempt. When hundreds of thousands of people huddle into small areas, and create there smoke, dust and noise, they suffer not only from new diseases, but from the exacerbation of diseases not wholly unknown to them in their rural condition. Under such unfavorable conditions of residence and labor the human body degenerates in many respects, and, losing vigor, becomes in some respects less able to resist the attacks of disease.

Against these bodily evils which result from civilization the physician has thus far struggled chiefly by treating more or less successfully the numerous individuals who are attacked by disease. Doubtless the treatment of sick and injured persons has substantially improved; but, nevertheless, the death-rate in our cities diminishes slowly, and the heavy economic losses which result from disease and premature death continue. Moreover, the improvement of treatment in hospitals and private practise has been accompanied by a great increase in the cost of treatment; so that the charges upon the community resulting from sicknesses and injuries have within the last thirty years rapidly mounted, and these heavy charges are, after all, incurred for the palliation of evils already suffered, and not for the prevention of such evils. Again, in different parts of the habitable globe mankind has been exposed for centuries to dangers more or less localized; in one region to the attacks of venomous reptiles, in another, of fierce carnivora, in another, to the ravages of flights of insects which devour every green thing, in another, to the constant presence of formidable diseases. For the most part, the human race has learnt how to exterminate the offending creatures, or at least to limit their ravages; and where grave infectious diseases are always present in greater or smaller degree, or frequently recur, a considerable proportion of the population becomes in some degree immune to them. Mankind is now in face of enemies which are not localized, but which, on the contrary, are carried all over the habitable globe on the ubiquitous routes of travel and commerce. The worst of the new enemies are minute, multitudinous and mysterious in that their relations and connections are unknown; they infest many of the animals with which man is associated, or pass into man from the animals and plants of which he makes use. Untrammelled dissemination of noxious

things has taken the place of centuries-long localization, a localization which sometimes secured checks, antidotes or immunities. Since, then, modern society can not help incurring new risks, it should seek new defenses. These defenses it may reasonably expect medical education to plan, and public and private expenditure to provide.

If civilized society is to endure under its new exposures and dangers, it is clear that the medical profession must take up with new ardor the work of preventing approaching disease in addition to the work of treating disease arrived. The profession must recognize that health is eminently a social product, just as the psychologists have recognized that the mind of a civilized man is a social product.

When we consider what has already been learnt about the production, transmission and prevention of smallpox, cholera, yellow fever, the black death, typhoid fever, diphtheria, anthrax, rabies and tetanus, we can not resist the conclusion that in the future medical science must include the study of causes and sequences which will carry the student through a large portion of the animal and vegetable kingdoms, and particularly into the habits and habitats of their minute parasitic forms. Systematic medical education must, therefore, produce a considerable number of men capable of studying in this region the causes of disease, and the ways of interrupting the means of communication, or breaking the chain of sequences, through which at last the germs of disease get a chance to produce their malignant effects within the human body. Considering the great obscurity of the physiological processes which go on within the body and the dense ignorance of mankind concerning the microscopic animal kingdom, it is a great wonder that medical science in its imperfect state has constructed so many effective defenses against disease within the last thirty years. Indeed, we are now using some efficient defensive methods, the real nature of which we but imperfectly understand, as for instance, the vaccinations against smallpox and hydrophobia. Although we are not yet able absolutely to prevent disease, we are able in many cases to restrict the communication of diseases and to modify their course in the individuals attacked.

The medicine of the future has, therefore to deal much more extensively than in the past with preventive medicine, or in other words, with the causes of disease as it attacks society, the community, or the state, rather than the individual. The object in view will be not only to arrest or modify a malady which has appeared in the body of a patient, but, as in the recent case of yellow fever, to learn how the disease is communicated and how to prevent that communication. The study of mitigations, remedies and cures is to continue; but the study of the causes of disease and the means of prevention is to be greatly developed. The function of the nineteenth-century physician will continue, and indeed will become more effective through a better knowledge of the forces which may be made to act upon his patient both from within and from without; but another sort of physician will be at work in the twentieth century preventing the access of epidemics, limiting them when they arrive, defending society against bad food and drink, and reducing to lowest terms the manifold evils which result from the congestion of population. The explorers and pioneers in medical science must be encouraged to press on their patient work of analyzing all the processes which accompany disease, in order that they may learn their actual sequences. Only through the knowledge of these sequences can real control over disease be certainly gained. And this

work will be endless; for civilization involves constant changes in the environment of the human race; and it is on medical science that the race must depend for protecting it from the new dangers which accompany each novel environment. The medical scientists being provided and furthered, medical education must also train large bodies of men to clear and cultivate the regions through which the pioneers have made trails, or, in plainer words, to apply to millions of men and women in all sorts of climate and environment the discoveries of the scientists. Thus thousands of physicians all over our southern states must for years be teaching the people how to protect themselves from yellow fever. Major Walter Reed and his colleagues proved how yellow fever is communicated, and—what was equally important—how it is not communicated; but thousands of medical men must see to it that intelligent application is made of that precious knowledge.

Recent events have brought into strong light a new function of the medical profession which is sure to be amplified and made more effective in the near future. I mean the function of teaching the whole population how diseases are caused and communicated, and what are the corresponding means of prevention. The recent campaign against tuberculosis is a good illustration of this new function of the profession. To discharge it well requires in medical men the power of interesting exposition, with telling illustration and moving exhortation. Obviously the function calls for disinterestedness and public spirit on the part of the profession; but to this call it is certain that the profession will respond. It also calls for some new adjustments and new functions in medical schools, which should hereafter be careful to provide means of popular exposition concerning water supplies, foods, drinks, drugs, the parasitic causes or consequences of disease in men, plants and animals, and the modes of communication of all communicable diseases. Medical museums should be arranged in part for the instruction of the public, and with some suitable reservations should be statedly open to the public. The medical schools should also habitually provide popular lectures on medical subjects, and these lectures should be given without charge on days and at hours when working people can attend. In other words, selected physicians should become public teachers, as well as private practitioners. America has much to learn from Europe in regard to this public-spirited service on the part of the profession.

In another respect the teaching of medicine must be broadened in the century we have now entered on. Medical study has been in time past far too exclusively the study of man's body by itself. Hereafter the study of medicine must be largely comparative, or in other words, must include man's relations to the animal and vegetable kingdoms. The Harvard Medical School enters into possession of its new buildings with three professorships of comparative medicine already established, the professorships of comparative anatomy, comparative physiology and comparative pathology. This tendency to comparative study has been already well developed in other subjects, as for example, in comparative psychology, legislation and religion. Wherever this study by comparison wins adequate place, it makes the study of the subject broader and more liberalizing, and the results obtained more comprehensive and juster. Medical students should, therefore, have studied zoology and botany before beginning the study of medicine, and should have acquired some skill in the use of the scalpel and the microscope. It is absurd that anybody should begin with the human

body the practise of dissection or of surgery; and, furthermore, it is wholly irrational that any young man who means to be a physician should not have mastered the elements of biology, chemistry and physics years before he enters a medical school. The mental constitution of the physician is essentially that of the naturalist; and the tastes and capacities of the naturalist reveal themselves, and, indeed, demand satisfaction long before twenty-one years of age, which is a good age for entering a medical school. The Harvard Medical School has derived great advantages from its requirement of a previous degree for admission; but in view of the fact that many young men procure a bachelor's degree without ever having studied any science, the school needs an additional and more specific requirement, namely, a previous knowledge of biology, physics and organic chemistry, and an acquaintance with laboratory methods in all three subjects.

As at the preliminary stages of the medical career, so at its climax there is an increasing need of men who have a working knowledge of several sciences which were formerly treated as distinct, and whose best representatives in medical schools labored apart each in his own field. The most promising medical research of our day makes use of biological, chemical and physical science combined. Physiology advances by making applications of the principles, the methods and the implements of all three sciences. The physiologist listens to the normal or abnormal sounds in the bodies of men and animals with a modified telephone, and may record by electricity almost all the phenomena he studies. Bacteriology and biological chemistry go hand in hand in serving pathology and the public health. A great number of new chemical substances, coming from organic sources, and yet as definite and uniform in composition as salt or alum, prove serviceable in pharmacology, and in physiological and pathological research, although they were neither discovered nor manufactured with any such purpose in view. The stainings of bacteriological technique, and the quantitative color tests for characteristic ingredients in the various secretions of the body, ingredients which fluctuate in amount in health or in disease, illustrate the present dependence of medical research on chemistry and physics. For the effective study of the toxins and antitoxins, within and without the body, the bacteriologist and the biological chemist must cooperate. Many of the effects produced by the toxins in the living body are definite chemical changes, such for instance as may be produced by the activation of certain ferments, and the antagonism of toxin and antitoxin is probably a chemical reaction. Many of the great discoveries of the future will come through the cooperation of sympathetic groups of medical scientists representing different modes of attacking the same problem. There will be a like necessity for cooperation between the clinician, the pathological anatomist, the physiological chemist and the bacteriologist.

The world has observed, and will not forget, that some of the greatest contributors to the progress of medicine and surgery during the past thirty years have been, not physicians, but naturalists and chemists. Pasteur was a chemist, Cohn, the teacher of Koch, a botanist, and Metchnikoff a zoologist. Students of disease must, therefore, be competent to utilize in their great task every aid which natural science can furnish. How vastly is the range of medical science and medical education broadened by this plain necessity! The dignity and serviceableness of the medical profession are heightened by every new

demand on the intelligence and devotion of its members.

The recent liberal endowment of the Harvard Medical School by private persons is an indication that the more intelligent and public-spirited portion of the American people is beginning to understand that most diseases would be preventable, if only mankind had acquired the knowledge needed to prevent them. The urgent duty of society to-day is to spend the money needed to get that knowledge. How to spend it we have learned—witness the admirable work of the Massachusetts Board of Health for thirty years past, aggressive work both defensive and offensive; witness also the remarkable results of the medical institutes both in this country and in Europe.

The medical profession of the future will have the satisfaction not only of ameliorating the condition or prolonging the life of the suffering individual, but also of exterminating or closely limiting the preventable diseases. CHARLES W. ELIOT.

THE UNITY OF THE MEDICAL SCIENCES.[1]

THE dedication of the new buildings of the Harvard Medical School is an occasion for rejoicing, not to Harvard University alone, but to all in this country and elsewhere interested in the progress of medical education and of medical science, and in behalf of all such I beg to offer to this university hearty congratulations upon this magnificent addition to its resources for medical teaching and study. Medicine everywhere and especially in America has reason to be profoundly grateful to the generous and public-spirited donors who have made possible the construction of this group of buildings, unsurpassed in the imposing beauty and harmony of their architectural design and in their ample, internal arrangements. This design is adapted from the Greek, and it is peculiarly fitting that the medical sciences should be housed in a style which suggests the spirit of ancient Greece, where first flowed the springs of medical science and art, living springs even to this day. In the singular harmony of the architecture of the group of buildings devoted to the various medical sciences are typified the unity of purpose of these sciences and their combination into the one great science of medicine. What I shall have to say on this occasion is suggested in part by this thought of the 'Unity of Medical Science.'

The good fortune of the Harvard Medical School in coming into possession of the splendid laboratories now formally dedicated is well merited by the leading position which this institution has held in this country since its foundation, by its union with Harvard University and by the assurance that the greatly enlarged opportunities will here be used to the highest advantage. Since the appointment in 1782 of its first professors, John Warren and Benjamin Waterhouse, of enduring fame, this school has had a long line of honored names upon its roll of teachers, lustrous not only for such single stars as Channing and Ware and Holmes and Ellis and Cheever, but especially for its clustered stars, the Warrens, the Jacksons, the Bigelows, the Shattucks, the Wymans, the Bowditchs, the Minots; and it will not be deemed invidious on this occasion to mention of the latter group the names of two members of the present distinguished faculty to whose services this school is so largely indebted for securing the funds for the new buildings, Professor Henry P. Bowditch, the eminent leader of American physiologists, and Professor John Collins

[1] An address delivered by William H. Welch, M.D., LL.D., professor of pathology, Johns Hopkins University, on September 26, 1906, at Harvard University, at the dedication of the new buildings of the Harvard Medical School.

Warren, who as surgeon, writer and teacher has so worthily maintained and enhanced the ancestral fame.

The Harvard Medical School has been a pioneer in this country in many improvements of medical education; it has stood successfully in an historic city and commonwealth for high standards of professional attainment and honor and for just recognition of the dignity and usefulness of the profession; it has made valuable contributions to the advancement of medical knowledge and practise, and above all there issued from this school and the Massachusetts General Hospital through John Collins Warren, the elder, and Samuel G. Morton medicine's supreme gift to suffering humanity of surgical anesthesia.

This school, however, has no possession so valuable or which gives such assurance of its stability and growth for untold generations to come and of the worthy bestowal of the great gifts which were dedicated yesterday as its union with Harvard University, and it is befitting that the significance of this university relationship should be emphasized by including among the dedicatory ceremonies this academic function in the halls of this great university.

The severance of the historical union of medical school and university, leading to the establishment of a multitude of independent medical schools without responsible control and usurping the right to confer the doctor's degree and the license to practise, is accountable in large measure for the low position to which medical education in this country sank during the larger part of the last century, and from which it has now risen in our better schools to a height which we can contemplate with increasing satisfaction. Nor would it be difficult to show, if this were the suitable occasion, that our universities on their side have suffered from the loss of a member which has brought renown to many foreign universities and that many of the embarrassing anomalies of our collegiate system of education are due to lack of personal contact, on the part of colleges and universities, with the needs of professional, especially medical, training. There is of course no saving grace in a merely nominal connection of medical school and university; the union to be of mutual benefit must be a real and vital one; ideals of the university must inspire the whole life and activities of the medical department.

To have recognized fully from the beginning of his administration the importance of this vitalizing union of the medical school with the university, to have striven patiently with full grasp of the problems and with intelligent sympathy with the needs of medicine for the uplifting of the standards of medical education, and, with the aid of his medical colleagues, to have planted these standards where they now are in the Harvard Medical School is not the least of the many enduring services which President Eliot has rendered to American education, and, in behalf of our profession, I wish to make to you, sir, on this occasion grateful acknowledgment of this great and beneficent work.

The opening of the new laboratories of the Harvard Medical School marks the culmination, up to the present time, of an educational and scientific movement which has been the most distinctive characteristic of the development of medicine during the past fifty years and which has transformed the face of modern medicine. To have some idea of the extent and the direction of this development consider how inconceivable would have been the mere existence of such laboratories a century ago, and how impossible it would have been

for even a Bichat or a Laënnec to have put them to any use or to have imagined their use. The only scientific laboratory which existed at that time was the anatomical, and this had been in existence for at least two hundred and fifty years, although not in a form which meets our present ideas of such a laboratory.

The modern scientific laboratory was born in Germany in 1824 when Purkinje established the first physiological laboratory, thus antedating by one year the foundation of Liebig's chemical laboratory, which had a much greater influence upon the subsequent development of laboratories. As might naturally be expected, anatomical and physiological laboratories had attained a considerable development before the first pathological laboratory was founded in Berlin by Virchow. The opening and activities of this laboratory, which has recently celebrated its fiftieth anniversary, mark an era in the progress of medicine. With the exception of the modest beginning of a pharmacological laboratory by Buchheim about 1850, all of the other medical laboratories—those of physiological chemistry, of hygiene, of bacteriology, of clinical medicine—originated at a much later date.

This remarkable growth of laboratories for the cultivation of the various medical sciences has been at once the cause and the result of the rapid progress of medicine in recent years. By teaching and exemplifying the only fruitful method of advancing natural knowledge laboratories have overthrown the dominance of authority and dogma and speculation and have turned medicine irrevocably into the paths of science, establishing the medical sciences as important departments of biology; by demonstrating that the only abiding, living knowledge, powerful for right action, comes from intimate, personal contact with the objects of study they have revolutionized the methods of medical teaching; by discovery they have widened the boundaries of old domains and opened to exploration entirely new fields of knowledge, by the application of which man's power over disease has been greatly increased.

Medicine, as a science, is occupied with the systematic study of the structures and functions of the human and animal body in health, of their changes by disease and injury, and of the agencies by which such morbid changes may be prevented, alleviated or removed. Its ultimate aim, which indicates also its method, is that of all science, the deduction of general concepts and laws from the comparison of the relationships and sequences of ascertained facts, and the application of these laws to the promotion of human welfare. This goal, to-day far from realization, is most nearly approached where the principles of physics and of chemistry can be applied, but there remains a large biological field awaiting reclamation for the application of these principles. The subject matter of medical study, as thus indicated, is of supreme import to mankind, but complex and difficult far beyond that of any other natural or physical science.

The places where such study may be most advantageously carried on are laboratories and hospitals supplied with the material for study, with the necessary instruments, appliances and books, and with trained workers. By growth of medical knowledge the field to be covered has become so vast as to require much subdivision of labor, nor is it to be supposed that the end of this subdivision has been even approximately reached.

From human anatomy, the mother of medical as well as of many other natural sciences, there branched off in the eighteenth century physiology, and, still later,

pathological anatomy. As if to replace these losses anatomy gave birth to comparative anatomy, embryology and microscopic anatomy as more or less separate branches.

During the past century physiological chemistry and pharmacology have separated from physiology, and comparative pathology and experimental pathological physiology are asserting their independence from pathological anatomy.

Hygiene and bacteriology are of recent and more independent growth. The latter, lusty stripling, with the rise of medical zoology, especially protozoology, is seeking a more comprehensive and appropriate designation. The latest and, perhaps, the most significant development is the clinical laboratory in its various forms.

Specialization in scientific work should not be decried; it is demanded by the necessities of the case and has been the great instrument of progress, but the further division of labor is carried, the more necessary does it become to emphasize essential unity of purpose and to secure coordination and cordial cooperation of allied sciences. Especially urgent is full recognition of the unity and cooperation of the clinic and the laboratory.

During the last two decades we have witnessed in this country the extraordinary rise of practical laboratory instruction from the weakest to the strongest and best organized part of the medical curriculum of our better schools. Our laboratory courses are, I believe, in several instances more elaborate and occupy more time than corresponding ones in most foreign universities.

As was emphasized by Dr. Dwight and Dr. Shattuck in their remarks yesterday, it is, however, an error to suppose that from the point of view of science any fundamental distinction exists between the clinical and the so-called laboratory subjects other than that based upon differences in the subject-matter of study. The problems of the living patient are just as capable of study by scientific methods and in the scientific spirit and they pertain to independent branches of medical science just as truly as those of anatomy, physiology or the other so-called laboratory subjects. All of the medical sciences are interdependent, but each has its own problems and methods, and each is most fruitfully cultivated for its own sake by those specially trained for the work.

There is a highly significant and hopeful scientific movement in internal medicine and surgery to-day characterized by the establishment of laboratories for clinical research, by the application of refined physical, chemical and biological methods to the problems of diagnosis and therapy, and by the scientific investigation along broad lines of the special problems furnished by the living patient. The most urgent need in medical education at the present time in this country I believe to be the organization of our clinics both for teaching and for research in the spirit of this modern movement and with provision for as intimate, prolonged, personal contact of the student with the subject of study as he finds in the laboratory.

In addition to undergraduate instruction our laboratories at present furnish better opportunities for the prolonged, advanced training of those intending to make their careers in anatomy, physiology, pathology and other sciences, than are afforded by most of our hospitals to those who aim at the higher careers in medicine and surgery. A further clinical disadvantage is that while the former class after good scientific work may reasonably look forward to desirable positions as teachers and directors of laboratories, the latter,

however high their attainments, in consequence of the separation of the medical school from any control over the appointments to the hospital staff, can not anticipate with any degree of assurance similar promotion in their chosen lines of work, and consequently the medical faculty has not so wide a field of choice in filling the clinical chairs as in filling those of the auxiliary sciences.

The removal of these deficiencies on the clinical side of medical education in America requires some reorganization of its staff on the part of the hospital and the control by the medical school of its hospital, or, at least its voice in appointments to the hospital staff. So far as our resources permit, we have, I think, accomplished this reform at the Johns Hopkins Medical School and Hospital.

The welfare of the patient is the first obligation of the trustees of hospitals and of physicians in attendance, but nothing is more certain than that cordial cooperation between medical school and hospital best subserves the promotion of this welfare. Fortunate the hospital and fortunate the patients brought into such relations with the Harvard Medical School.

As is strikingly illustrated by the new buildings of this school, the educational machinery of medicine to-day is vastly complicated and costly compared with the simplicity of the days when a lecture room, a dissecting room, a simple chemical laboratory and a clinical amphitheater were all that was needed. The purpose of medical education, however, remains to-day what it has always been and will continue to be —the training of the student for the future practise of his profession, and to this end in a harmonious scheme of education the various medical sciences all work together. Right action requires abundant knowledge, nowhere more so than in medical practise, and the all-sufficient justification for the position held by the various sciences in the preliminary and the professional education of the physician is that they furnish knowledge and discipline of mind needed in the preparation for his future work. The social position of the medical man and his influence in the community depend to a considerable extent upon his preliminary education and general culture. For this reason as well as for his intellectual pleasure in his profession and as a sound foundation for his future studies the student should enter the medical school with a liberal education, which should include training in the sciences fundamental to medicine.

The unity of the various medical sciences is manifested not only in their historical development and in their cooperation in the scheme of medical education, but especially in their contributions to the upbuilding and progress of medicine as a whole.

There is no branch of medicine or even of physical science which has not played an important part in the evolution of our present medical knowledge and beliefs. The great lesson taught by the history of this development of medicine through the centuries has been the unconditional reverence for facts revealed by observation, experiment and just inference as contrasted with the sterility of mere speculation and reliance upon transmitted authority. The great epochs of this history have been characterized by some great discovery, by the introduction of some new method, or by the appearance of some man of genius to push investigation and scientific inference to limits not attainable by ordinary minds. The history of medicine has a greater unity and continuity and extends over a longer period of time than that of any other science.

The first clear note, which has rung down the ages, was sounded by Hippocrates when he taught the value of the inductive method by simple, objective study of the symptoms of disease, and the cry 'Back to Hippocrates' has more than once recalled medicine from dogmas and systems into sane and rational paths. Medicine, however, was handed on from the Greeks and Romans in bondage to a system of doctrine, constructed by Galen, so completely satisfying to the medieval mind that this system remained practically untouched for over a thousand years.

With the liberation of intellect through the renaissance came the great emancipators, in the sixteenth century, Vesalius and, in the seventeenth, Harvey, the former placing human anatomy upon a firm foundation and bringing medicine into touch with the most solid basis of fact in its domain, the latter bringing to light in the demonstration of the circulation of the blood the central fact of physiology and applying for the first time in a large and fruitful way to medicine the most powerful lever of scientific advance, the method of experiment.

In the century of Galileo, Harvey and Newton instruments of precision as the chronometer, the thermometer, the balance, the microscope, were first applied to the investigation of medical problems, and physics began to render those services to medicine which, continued from Galileo to Röntgen, have been of simply incalculable value. The debt of medicine to chemistry began even with the rise of alchemy, received an immense increment from the researches of Lavoisier, the founder of modern chemistry, concerning the function of respiration and the sources of animal heat, and has grown unceasingly and to enormous proportions up to these days of physical chemistry, which has found such important applications in physiology and pathology.

How disastrous may be to medicine the loss of the sense of unity in all its branches has been very clearly and admirably shown by Professor Allbutt in depicting the effects which for centuries followed the casting off from medicine of surgery as a subject unworthy the attention of the medical faculty. Thereby internal medicine lost touch with reality and the inductive method, and remained sterile and fantastic until the days of Harvey, Sydenham and Boerhaave. The services of surgery to medicine as a whole, so brilliantly exemplified in the experimental work of John Hunter in the eighteenth century, have become a distinguishing feature of the medicine of the present day.

The great awakening of clinical medicine came in the early part of the nineteenth century from the introduction of the new methods of physical diagnosis by Laënnec and from pathological anatomy. The subsequent development of scientific and practical medicine has far exceeded that of all the preceding centuries. It has kept pace with the progress during the same wonderful century of all the sciences of nature and has contributed even more to the promotion of human happiness.

In anatomy with embryology and histology, in physiology, pathology, physiological chemistry, pharmacology, hygiene, bacteriology—sciences which are ancillary to medicine and at the same time important branches of biological science—there have been marvellous activity and expansion. For physiology and the understanding of disease the establishment of the cell doctrine by the aid of botany, embryology and pathology has been the greatest achievement. By the combined aid of physiology, physiological chemistry, experimental pathology, improved methods

of diagnosis and clinical study, medicine has gained new and higher points of view in passing from too exclusive emphasis upon the final stages of disease revealed by morbid anatomy to clearer conceptions of the beginning and progress of morbid processes as indicated by disturbances of function, and above all has penetrated to the knowledge of the causation of an important class of diseases, the infectious. As a result of this rapid growth of knowledge in many directions has come a great increase in the physician's power to do good by the relief of suffering and the prevention and cure of disease.

In this connection I wish especially to emphasize the mutual helpfulness of the various medical sciences in the development of medical knowledge and practise. Attention is generally so concentrated upon the final achievement that there is danger of losing sight of the manifold sources which have contributed to the result. Let my medical hearers consider, for example, the indispensable share of embryology, of anatomy, gross and microscopic, of physiology, of pathological anatomy, of clinical study in the evolution of our knowledge of the latest contribution to diseases of the circulatory system—that disturbance of the cardiac rhythm called 'heart-block.' Similar illustrations of the unity of the medical sciences and of the cooperation of the laboratory and the clinic might be multiplied indefinitely from all classes of disease.

The same phenomenon is exhibited in medicine as in all science that the search for knowledge with exclusive reference to its practical application is generally unrewarded. The student of nature must find his satisfaction in search for the truth and in the consciousness that he has contributed something to the fund of knowledge on which reposes man's dominion over reluctant matter and inexorable forces.

How readily better action attends upon increased knowledge is shown by the part which the art of medicine is playing and is destined to play even more prominently in the world's progress. The value of this work of modern medicine is to be measured in part, but only in part, by the standard applied by the average man, namely, improvement, which, indeed, has been great, in the treatment of disease and injury. It is, however, its increasing power to check the incalculable waste of life, of energy, of money from preventable disease that places medicine to-day in the front rank of forces for the advancement of civilization and the improvement of human society. Economists and other students of social conditions have begun to realize this, but governments and the people are not half awake, and medicine, shaking off all mystery, and with a sense of high public duty, has before it a great campaign of popular education.

The knowledge which has placed preventive medicine upon a sound basis and has given it the power to restrain and in some instances even to exterminate such diseases as cholera, plague, yellow fever, malaria, typhoid fever, tuberculosis and other infections has come from exploration of the fields opened by Pasteur and by Koch. This power and the certainty of increasing it have given great strength to appeals for the endowment of medical research and the construction of laboratories. What is all the money ever expended for medical education and medical science compared with the one gift to humanity of Walter Reed and his colleagues of the army commission—the power to rid the world of yellow fever?

Great as has been the advance of medicine in the past half century, it is small

indeed in comparison with what remains to be accomplished. Only a corner of the veil has been lifted. On every hand there are still unsolved problems of disease of overshadowing importance. The ultimate problems relate to the nature and fundamental properties of living matter, and the power to modify these properties in desired directions. Here we are far from the satisfactory *pou sto*. But knowledge breeds new knowledge, and we can not doubt that research will be even more productive in the future than it has been in the past. It would be hazardous in the extreme to attempt to predict the particular direction of future discovery. How unpredictable even to the most far-sighted of a past generation would have been such discoveries as the principles of antiseptic surgery, antitoxins, bacterial vaccines, opsonins, the extermination of yellow fever or malaria by destruction of a particular species of mosquito and many other recent contributions to medical knowledge.

The activities within the new buildings of the Harvard Medical School begin at a period of medical development full of present interest and full of hope for the future, and it may be confidently predicted that they will have an important share in the onward movement, educational and scientific, of medicine.

One side of these activities will be devoted, under conditions most admirable as regards teachers, methods and opportunities, to the training of medical students and to advanced instruction. Supplemented by similar opportunities for undergraduate and advanced training in the hospital wards and dispensary these conditions will be ideal.

The inspection of these noble new buildings, however, shows clearly that those who have planned them with such care, foresight and sagacity, while recognizing fully their important educational uses, have had also another and a main thought in their arrangements, namely, their adaptation to the purposes of original research. It is this dual function of imparting and of advancing knowledge which justifies the expenditure of money and which insures a return of the capital invested in buildings, equipment and operation with a high rate of interest in the form of benefits to mankind.

The most ample and freely available facilities are an important condition for productive research, but on this creative side of university work men count for more than stately edifice and all the pride and pomp of outward life. Research is not to be bought in the market place, nor does it follow the commercial law of supply and demand. The multitude can acquire knowledge; many there are who can impart it skilfully; smaller, but still considerable is the number of those who can add new facts to the store of knowledge, but rare indeed are the thinkers, born with the genius for discovery and with the gift of the scientific imagination to interpret in broad generalizations and laws the phenomena of nature. These last are the glory of a university. Search for them far and wide beyond college gate and city wall, and when found cherish them as a possession beyond all price.

By the possession of investigators such as these, by the character and work of teachers and taught, by the advancement of knowledge and improvement of practise, may this new home of the Harvard Medical School, be a center for the diffusion of truth in medicine, the abode of productive research, a fortress in the warfare against disease, and thereby dedicated to the service of humanity.

WILLIAM H. WELCH.

SCIENTIFIC BOOKS.

Geology. By T. C. Chamberlin and R. D. Salisbury. 3 vols. 8vo, illustrated. New York, Henry Holt & Co. Vol. I. *Geologic Processes and their Results.* Pp. xix + 654. 1904. Vol. II. *Earth History (Genesis-Paleozoic).* Pp. xxvii + 692. 1906. Vol. III. *Earth History (Mesozoic, Cenozoic).* Pp. xi + 624. 1906.

The appearance of this monumental work is an event of more than ordinary importance in the history of geologic book-making. The authors are men of great and varied experience in field geology in different parts of the world, and they are thoroughly skilled in handling the more abstruse problems of speculative geology. They are also too serious-minded and too actively engaged in geologic research to give their time to the preparation of a text-book or manual of geology of the ordinary type. The geologists of the country and of the world, therefore, feel that they have a right to expect in these three volumes to find geology not only brought well up to date in all its branches, but new fields pointed out for future activity, research and philosophic deduction.

But if such a work should fully meet all of the hopes and expectations of all geologists it would have to be more than human. No man and no two men can publish a text-book of 2,027 pages on geology without omitting many things that some of us think ought to have gone in, and without putting in much that some of us think ought to have been left out. In these days of specialization, too, the help of many specialists must be had in the preparation of such a book, and even the specialist is often a little behind one or another colleague regarding details of some importance in his own specialty. Aside from the matter of scientific import, the mere mechanical preparation and editing of such a book is a task of no small responsibility. But none the less authors of books that are to be taken seriously must expect to have their work scrutinized with a closeness and minuteness proportionate to the seriousness of their undertaking.

One of the most useful features of a good manual for advanced students, such as this work claims to be, is its reference to geologic literature. Two of the best manuals in the English language stand in strong contrast to each other in this respect: Dana's manual, hitherto our best American work, is notably lacking in foot-note references, while Geikie's text-book has abundant and discriminating references to the literature of every subject treated. The first two volumes of Chamberlin and Salisbury have entirely too few references to the literature of geology, and of these, too many are to text-books instead of the original sources, and where original sources are mentioned the references are sometimes not up to date. This sort of thing is allowable in elementary works, but hardly so in one of these dimensions.

The geographic part of the first volume is beautifully illustrated with colored topographic plates, a happy and thoroughly effective method of showing certain geographic features, but these plates are not accompanied by explanations, nor do they contain references to places in the text where they are explained. The text itself refers here and there to the plates, but one gets tired of hunting for plates and counting them and looking for their numbers in an effort to follow the text intelligently. Some of these plates might have been much improved by striking out certain lines from the originals. On plate XVI. (opposite p. 179, Vol. I.), for example, the heavy broken black line down the middle of the Missouri River might better have been omitted. There are but few of these otherwise beautiful illustrations that are not marred by these heavy black political boundary lines.

The language is sometimes obscure. We are no sticklers for making everything easy for the student, but we do believe in making it simple when it may as well be simple as complex and difficult to follow. Students need to give their time to thinking about the subject on hand instead of wondering what a writer is driving at. For example, at p. 265 of Vol. I., it is said that 'this dynamic source of heat may modify the theoretical deductions

drawn above from the atmospheric and internal influences.' On p. 338 it is said of waves normal to the shore that 'the advance and recoil of the water move particles toward and from the shore, but effect no transfer in the direction of the shore,' probably meaning along the shore. Again at p. 429 it is said: 'If the heat factor in metamorphism be sufficiently increased, aqueous solution may actually grade into magmatic solution through various degrees of softening and melting, and the cycle of changes be closed in upon itself.

Personally, we do not think well of the frequent personification of natural objects. For example, streams are spoken of in Vol. I. as if they had designs: they are said to struggle (p. 95), to steal (p. 98), to commit piracy, to drop out of the race (p. 96), to refuse to remain (p. 169), to have feeding grounds (p. 516), senility and death (p. 85); a lava stream chooses its direction (p. 580), and in one place a volcano is said to be 'enjoying its customary period of rest' (p. 571). This sort of language is as much out of place in geology as it would be in chemistry or physics.

While some subjects are treated with great fullness others are passed over with next to no attention. The theory of isostacy, for example, is barely mentioned twice, while the process and importance of flocculation in the deposition of finely divided sediments is only referred to on p. 360 of Vol. I. as a limited and obscure action. A brief bibliography of the subject of flocculation is given in *Nature*, LXIV., 279, and some of its obscurity has been removed by Joly and others there mentioned.

The general subject of coral reefs is dismissed (I., 630) with the remark that, 'The contribution of coral polyps to the formation of limestone is most important, and is too familiar to require elaboration here.' Most of us who think that corals form only dolomites and dolomitic limestones can not be expected to accept this dismissal of the subject as a fair disposal of it, especially in view of the promise made on p. v of the introduction to Vol. I., where it is stated that 'Antecedent elementary courses in geology will not be necessary to the use of these volumes.'

There are many oversights that must annoy teachers of geology, especially in view of the fact that students, as every teacher knows, are so much disposed to regard text-books and statements in print as infallible. The following are some of the statements in Vol. I. that do not seem to be altogether above question or require modification or explanation: on page 501 it is said that 'faults rarely show themselves in the topography of the surface.' A California geologist could hardly be expected to support such a statement with a straight face. On p. 150, figure 146, a syncline is called an anticline. On p. 170 the decrease in the volume of a stream is explained in every way except the one in which we most frequently see it decreased, namely, the run-off of flood waters. It is said on p. 184 that theoretically the rotation of the earth should increase erosion on 'the right bank of streams in the northern hemisphere and the left in the southern,' when no reference is made to the direction of the streams. On p. 188 mention is made of 'the load except that in suspension,' when solution seems to be meant. The branching of streams amidst their delta deposits is explained (p. 189) by water breaking over side-levees. Some branches may possibly be so formed, but this explanation can not be accepted for the main divisions of the Mississippi at its mouth. In explaining river terraces (p. 198) no mention is made of a stream swinging back and forth across a flood plain in which it is cutting a channel. It is stated (p. 213) that the deposition of mineral matter from boiling water is the same process as that by which it is deposited upon evaporation: we have not been accustomed to think so. In listing the factors of deposition from solution no mention is made (p. 214) of either increase of temperature (with the carbonates), or of the escape of gases, such as carbon dioxide, from waters disturbed at waterfalls. On p. 218 natural bridges are called 'unique features.' The statements on p. 277 lead one to suppose that fiords are only made by glaciers.

The depression of the island of Hawaii would produce remarkably fine fiords.

In explaining the movements of sea water (p. 319) no mention is made of the lagging of waters moving over a revolving globe. On the same page the difference in densities of sea water is said to be due to differences in temperature and salinity, as if salt were the only mineral in solution in sea water. On p. 478 it is said that a dip of 40° S. 20° W. is the same as dip 40° strike W. 20° N. It may be the same, but it may also be N. 20° E., that is, in exactly the opposite direction. Moreover, it is customary to read the compass from the N. or S. end, not from E. or W. In Fig. 399 on p. 482 the strike should, therefore, read N. 80° E., instead of E. 10° N. The figure seems to be intended for a note-book record, but unless placed on a map it would be useless, for no direction is given for the dip. The writer's experience shows that dips indicated by arrows never mislead, while dips shown by plain lines (pp. 482–4) require an effort of the memory on the part of the student.

It is suggested (p. 507) that earthquakes cause the great waves that sometimes accompany shocks by thrusting their 'waters off shore by their sudden impact.' The late California earthquake was certainly violent enough to have given us an example of this kind of a wave if such a thing had been possible.

On p. 615 is 'the inference that a vegetal covering of the land extended as far back in the history of the earth as clay shales, quartz-one sandstones and limestones form the prevailing sediments.' The reasons for this inference are not clear. Long ago Daubrée demonstrated that feldspars mechanically ground up in the presence of water become kaolinized; this process would account for clay shales without the intervention of organic acids to decompose feldspathic rocks. Neither is it clear how land plants are indispensable to the formation of limestones. The carbon dioxide of waters is derived partly from the atmosphere. Lime carried to the sea by waters so carbonated would contribute to lime-secreting organisms, and limestone would thus be formed without the intervention of land plants.

The examples of deposits of diatoms (I., 625) might well include some of the great deposits such as those of the Santa Cruz Mountains of California, where they are five thousand feet thick.

In regard to the meteorite figured in Vol. II., p. 24, after Liversidge (not Liveridge) we venture to suggest the possibility of its having been artificially shaped. Its size and form appear to lend support to this idea. The authors do not say where it is described, but the original paper is in the *Jour.* and *Proc. Roy. Soc. of N. S. W.*, Vol. 36, p. 341. The description of the finding seems to preclude the possibility of its artificial origin, but experience shows that the stories associated with the finding of such things often require close scrutiny. The form of this meteorite is too unusual to be accepted without question.

In Vol. II., p. 653, the advent of the Ammonites is spoken of as occurring in the Permian. It was shown several years ago that the Ammonites were abundant in the Coal Measures (Mon. XLII., U. S. G. S., 22–28, Washington, 1903). In Vol. III. but little attention is paid to the stratigraphy of the west coast, and one might infer that the standard sections of the Mesozoic and Cenozoic were all in the eastern part of the United States. As a matter of fact, the finest sections of the Trias, Jura, Cretaceous, Miocene, Pliocene and marine Quaternary in North America are found on the west coast. One would also be led to infer from the illustrations that only land life was known in the Pleistocene of the United States, whereas marine life is certainly of equal importance and has been fully described.

The discussions that stand forth prominently in the entire work on account of their far-reaching importance and on account of the care, seriousness and comprehensiveness with which they are discussed are: (1) the planetesimal hypothesis of the origin of the earth; (2) the origin of the atmosphere; (3) the origin of the ocean; (4) of volcanic phenomena; (5) of the hydrocarbons; (6) of life.

Although most of the theories formally set forth in the book have now been before geologists for several years (always from these same authors), it can not be said that these theories have as yet met with general acceptance either in this country or among the geologists of other countries. They must, therefore, be regarded as still on trial in a sense. None the less, these volumes are an epoch-marking work, and the theories set forth in them must be reckoned with hereafter in every book on geology and by every teacher and every student. In spite of its two thousand pages one feels that the matter is much condensed, and the authors impress the reader with their judicial attitude of mind, with their mastery of the subjects treated, and reserve force in their statements and discussions. Working geologists the world over owe the authors something too for their having spared us another new terminology or a new system of spelling. They seem to stand godfathers only to the new petrographic nomenclature given in abstract on pages 433–8 of Vol. I.

The illustrations, especially the half-tones, are abundant, excellent, and new to our text-books, though the line drawings are hardly up to the standard of the rest of the book. The work of the book manufacturer leads us to hope that the day is not far distant when publishers will find some way of making an illustrated octavo volume of six hundred pages without its weighing close to four pounds.

The principal adverse criticisms that can be made relate to the minor details of editing —not to the subject-matter or to the method of treatment. In the presence of so much that is large, and helpful, and inspiring such criticisms seem like mere quibbling. Not a subject is touched upon in the entire work that does not have the breath of a new life breathed into it.

J. C. BRANNER.

The Eye, its Refraction and Diseases: Diseases of and Operations upon the Eyeball and its Adnexa. By EDWARD E. GIBBONS, M.D., Assistant Surgeon to the Presbyterian Eye, Ear and Throat Hospital; Demonstrator and Chief of Clinic of Eye and Ear Diseases in the University of Maryland, Baltimore. Vol. II., pp. viii + 632. New York, The Macmillan Co. 1905.

Medical text-books may be classified according to their size or according to their character. The criterion of bulk is not necessarily a high one, but if a book is made of two large volumes it must be taken seriously and permitted to enter the lists with certain approved productions of well-known teachers.

There are a few text-books that stand out preeminently with a distinct individuality, in which the author shows that he has the matter or the method to justify the book's existence. Other books owe their lives to the patronage of growing groups of students, who feel in the printed lines the personality of the teacher to whom they have listened. This class does not always appeal to the larger public, and unless the teacher is of wide and rare experience it is apt to be uneven and to consist in part of a somewhat undigested collection of statements from unproved sources. This is unfortunately the impression made by the work under consideration. The first volume, which has been reviewed in these columns, was a book of more value because the author wrote with authority. Physiological optics and its application to the refraction of the eye was evidently a familiar field, and the book was welcome because there are very few writers in our language who can treat this difficult subject clearly and interestingly. This volume deals with the diseases of the eye and shows industry and a wide acquaintance with current literature. No author can be familiar with all the methods of treating disease in these prolific times, and an open mind is justified, but it may be misleading to the student, to group methods not sufficiently tried with those of proved value, without giving marked prominence to the latter.

A few positive criticisms must be made, however thankless the task. The important subject of localization of foreign bodies in the eye is insufficiently treated. There is no allusion to the frequent association between ocular disorder and disease of the nose and neighboring sinuses, and this is the more surprising

since to the less important association of eye and ear an entire chapter is given. The consideration of migraine and hysteria leaves much to be desired. The colored pictures of the fundus are rather sketchy. The index is not as complete as it should be to permit rapid reference, nor is the paragraphing well marked. The work of the publisher is excellent as regards paper and type. The unusual breadth of page gives a sense of solidity to the text which is hardly restful.

In spite of these faults and certain minor errors in the spelling of proper names, the book is a creditable one and with its very excellent companion volume will no doubt prove a useful addition to medical literature.

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New York City.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Comparative Neurology and Psychology for September is devoted almost entirely to psychological papers. Mr. Charles Scott Berry first gives the results of an investigation of 'The Imitative Tendency of White Rats,' made at the Harvard Psychological Laboratory. One animal was taught various tricks alone and then observations were made to determine how far others would learn the tricks from him by imitation. He concludes that voluntary imitation (Morgan's usage) of a certain type does exist in white rats; and though this is not of as high degree as that discovered by Kinnaman in his experiments with monkeys, it is not different in kind. The next two papers are fragments selected from a large mass of MSS. by the late C. L. Herrick left unfinished at the time of his death. In 'Applications of Dynamic Theory to Physiological Problems,' Dr. Herrick applied in a concrete way to the problems of heredity and vitalism the conception of 'dynamic monism' which he had begun to develop in the philosophical journals. This is followed by a brief note on 'Imitation and Volition,' suggested by one of Professor Mark Baldwin's discussions. In the editorial column, under the title, 'Objective Nomenclature, Comparative Psychology and Animal Behavior,' Dr. Yerkes critically reviews the work of the objective school, and the methodological problems involved are discussed from a somewhat different standpoint by Dr. Bawden. Book reviews complete the number.

The Journal of Nervous and Mental Disease for October opens with an article by Drs. Mills and Weisenburg presenting the following propositions: (1) that the cortical representation of cutaneous and muscular sensibility is independent of motor representation, that it surrounds the motor zone; and that it is subdivided into a mosaic of centers, each center or group of centers being anatomically and functionally correlated to a motor center or centers; (2) that every muscle or group of muscles producing a movement or movements which are represented by separate centers in the cortex is topographically related to a segment of the skin which has also a definite cortical center, this center being correlated anatomically and functionally with the motor center; (3) that stereognostic representation like that of cutaneous and muscular sensibility and of movements has also its independent cortical area and is subdivided after the manner of the motor and sensory areas. This is followed by a continuation of a paper by Dr. Amberg, begun in the September issue, giving the histories of a number of cases of ear affections and mental disturbances.

DISCUSSION AND CORRESPONDENCE.

ON THE DOPPLER EFFECT.

In a recent number of Science (Vol. XXIV., p. 250) there appeared an article by Dr. Paul R. Heyl suggesting a plan for increasing the Doppler effect by observing a rapidly moving image instead of a moving source, the motion being magnified by placing the source just outside of the focus of a converging mirror. If, however, we consider that the wave-length of the separate rays (or, if preferred, of the elementary pencils) is independent of their point of intersection—in other words, of the position of the image—it appears that the only modification of wave-length observed in an instrument at rest relatively to the mirror will be due to the motion

of the source, and will be the same as if that were viewed directly. In other words, the change of wave-length depends on the *rate of change of optical path* from the source to the receiving apparatus. If the source is stationary and the mirror moved the effect is doubled whether the mirror is plane or curved.

The fallacy in Dr. Heyl's suggestion appears to lie in his considering a moving image as in all respects equivalent to a moving source. While this may be true as a proposition in geometrical optics, there is the essential physical distinction that the phase of the vibrations issuing from an image depends not only on the vibrations of the original source, but also upon the (optical) distance from that source. Doubtless if we were to follow the image with our spectroscope we should observe a change of wave-length due to the latter cause. However, even if we could surpass the feat of hitching our wagon to a star by hitching our instruments to the much more swiftly flying image, we should again have the same effect as if the source were viewed directly.

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SPECIAL ARTICLES.

GLACIAL STAGES IN SOUTHEASTERN NEW ENGLAND AND VICINITY.[1]

FOR some years the writer has been engaged on the problem of the differentiation of the Pleistocene deposits of Long Island and southeastern New England. Some of the results have already been published,[2] and reports discussing in greater detail the subdivisions recognized, and their correlation are in preparation. The completion of the reports, however, owing to the assignment of the writer to other lines of investigation, is likely to be considerably delayed, and it has, therefore, seemed advisable to present a brief statement of the Pleistocene succession in the region in question, as it is understood by the writer, in the columns of this journal.

[1] Published by permission of the director of the United States Geological Survey.

[2] 'Probable Representatives of the Pre-Wisconsin Till in Southeastern Massachusetts,' *Jour. Geol.*, Vol. 9, 1906, pp. 311–329. 'Probable Pre-Kansan and Iowan Deposits of Long Island, New York,' *Am. Geol.*, Vol. 32, 1903, pp. 308–312. 'Geology of Fishers Island, New York,' *Bull. Geol. Soc. Am.*, Vol. 16, 1905, pp. 367–390. 'Clays of Cape Cod,' Bull. 285, U. S. Geol. Survey, 1906, pp. 432–441.

Pleistocene Subdivisions.

In the area examined, which includes Long Island, Gardiner's Island and Fisher's Island, New York; Block Island and the coast of Rhode Island, and Martha's Vineyard, Nantucket, Cape Cod and the coast of Massachusetts northward to Boston, the Pleistocene events appear to have been as follows:

1. *Deposition of the Deeply Oxidized Tills and Weathered Gravels.*—At Brockton and Stoughton, in Massachusetts, and other points in the vicinity, there are several exposures of bright yellow or red till composed of the disintegrated remains of local rocks occurring in protected spots beneath the younger tills. In most cases these old tills rest on deeply weathered rock surfaces, and are believed to represent preglacial residual soils slightly reworked by the first ice advance, which appears to be pre-Kansan in age.

On Long Island the Cretaceous is overlain unconformably by several hundred feet of yellow-stained gravel containing a few deeply weathered or disintegrated granitic pebbles and an occasional erratic crystalline boulder. It was originally correlated with a part of the Pensauken of New Jersey, but was later given the name Mannetto by Veatch. It is believed to be pre-Kansan and to represent the outwash of the same glacier which further inland deposited the till described in the preceding paragraph.

2. *Long Period of Subareal Erosion.*

3. *Deposition of Granitic Gravels.*—These gravels were noted in 1903 by Veatch in the well borings of western Long Island, and in the following year were recognized by the writer in the cliffs of Block Island, Martha's Vineyard and Cape Cod. They have a maximum thickness of 100 or more feet and consist of

quartz and granitic pebbles, the latter being especially numerous in the borings of western Long Island, where the deposit seems to approach a till in character. Elsewhere the formation is often sandy and is to be regarded as an outwash from the second, probably the Kansan, glacier. The formation is known as the Jameco.

4. *Deposition of Red and Black Clays.*—These clays, known as the Gardiner, overlie the Jameco with an abrupt line of demarcation on Long Island, Fisher's Island and Block Island, and on Martha's Vineyard, Cape Cod and the Massachusetts coast to Boston. They carry a shell fauna, characteristic of a somewhat colder climate than at present. The maximum thickness is about 100 feet. In some places the clay occurs as a single bed, while at other localities it is split up into a series of clays interbedded with sands. The color varies from red, through gray and brown, to black. It is correlated tentatively with the Yarmouth interglacial deposits of the central states.

5. *Deposition of Fine Sand.*—Following the Gardiner clay a thickness of ten to thirty feet of fine sand, often almost quartz flour, was deposited. This has been designated the Jacob sand and is regarded as a transition between the Gardiner clay and the Herod gravel. It is the equivalent in part of the Sankaty beds of Nantucket, in which locality it is abundantly fossiliferous.

6. *Deposition of Granitic Gravels.*—These gravels, known as the Herod, reach a maximum thickness of 100 feet or more, and consist of layers of quartz and granitic pebbles alternating with beds of sand. They are thought to mark the beginning of a third ice invasion, possibly the Illinoisan. They occur at nearly all points from Long Island to Boston, at which locality they have been recognized beneath the till of the drumlins.

7. *Deposition of the Principal Till of New England and Erosion by Ice.*—This till, which on Long Island and Fisher's Island and Cape Cod has been called the Montauk drift, is a hard, compact, dark gray, often partly cemented till, having a maximum thickness of perhaps 75 feet on Long Island, but reaching more than double this thickness in the drumlins about Boston, which, with few, if any, exceptions, belong to this stage. It is usually oxidized to a depth of ten to twenty feet and is regarded as probably Illinoisan in age. In places the ice by which it was deposited cut deeply into the underlying formations, and the till may rest directly upon any of the older deposits. In such instances the drift often departs widely from its normal character, partaking of the nature of the local beds from which its materials were derived. It marks an actual invasion of the ice.

8. *Deposition of Granitic Gravels.*—These gravels, together with their included beds of sand and an occasional layer of brownish clay, resemble the Jameco and Herod formations and are regarded as marking the close of the third, probably the Illinoisan, stage. They may be seen at many points on Long Island and between that island and Cape Cod.

9. *Great Erosion Interval: Possible Deposition of Clay.*—Clays have been recognized above the Montauk drift in the vicinity of Plymouth, and appear to overlie the drumlins near Boston. These underlie the latest drift and may possibly belong to the Iowan stage. It may be said, however, that in the region south of Boston but little reliable evidence has yet been obtained of the existence of drift of this stage, although it is not improbable that it may be present. Deposition, at the best, appears to have been a minor feature in the interval between the gravels last mentioned and the latest till, the interval being characterized rather by extensive erosion, such as might be expected to mark a long period like the Sangamon-Iowan-Peorian interval rather than the Peorian interval alone, in which, judging from the evidences in the central United States, relatively little erosion was accomplished.

10. *Deposition of Thin Till.*—This till is usually from two to twenty feet in thickness and is ordinarily loose and bouldery rather than clayey, and is oxidized to a depth of only two to five feet. It constitutes the surface deposit over most of southeastern Massachu-

setts, but, because of its thinness, has not heretofore been separated from the main or drumlin drift (Montauk) and has even failed of recognition where present on the extensive sandy deposits of the Plymouth and Cape Cod regions of Massachusetts. On Long Island it is better developed and is everywhere recognized above the older gravels. It is presumably to be correlated with the latest drift of the Mississippi Valley—the Wisconsin.

M. L. FULLER.

UNITED STATES GEOLOGICAL SURVEY.

FOOD HABITS OF THE SNAIL BULIMULUS DORMANI BINNEY.

THE orange and other *Citrus* species, several ornamentals, and various greenhouse and other plants are often badly disfigured by the presence of a black saprophytic fungus,[1] *Meliola Camelliæ* (Catt.) Sacc. commonly known in the orange-growing region of Florida as the 'sooty mold' of the orange. The fungus feeds on a sweet honey dew exuded by various insects, especially species of Aphidæ, Coccidæ and Aleyrodidæ. The habits of the Aleyrodidæ species are very favorable to the growth of the fungus. This is especially true of the so-called 'white fly' of the orange, *Aleyrodes citri*. The larvæ of this species, attaching themselves to the under surface of the leaves, exude honey dew which, falling to the top surface of the leaves and stems beneath supplies nourishment for a heavy growth of the fungus. The white fly and the fungus are invariably associated, and a badly infested grove or hedge may be recognized at some distance by its heavily coated dark foliage. So dense is the covering of the intertwining hyphæ that the smothering layer is believed to interfere seriously with the healthy action of the sunlight on the leaves. The fruit as well as the leaves and stems is coated, and a thorough washing of the smutty oranges becomes necessary before marketing; an added expense is thereby incurred as well as increased danger of bruising from additional handling and washing, and, unless the oranges are quickly and properly dried, of decay in shipping from the wetting. The presence of the sooty mold is thus one of the most serious results of white fly infection of orange groves, and almost the only appreciable injury from this species to privet and other ornamentals, and is an important element in the injury to various plants from numerous other sucking insects.

The habits of the snail *Bulimulus Dormani* Binney[2] are of the greatest interest in this connection. This species, the normal food of which is apparently fungi, algæ and perhaps lichens, has been found during the summer of 1905 in numerous groves in Manatee County feeding on the sooty mold. The trees on which the snails are found stand out conspicuously among the surrounding trees by their bright foliage and fruit, and clean trunks, in contrast to the sooty leaves and fruit of the surrounding trees. The work of the snails on orange trees is well seen in the Willis grove of the Manatee Lemon Company near Palmetto, Florida. The trees of this grove are seedlings and reach a height of thirty to thirty-five feet. Snails are present on perhaps seventy-five trees and have completely overrun them from top to base, cleaning the fruit, leaves and trunks. The foliage of the trees not visited by the snails is densely coated by the sooty mold. The snails have not confined themselves to the fungus alone, but have freed the trees from algæ, and apparently some of the lichens. The snails are even more widely scattered in some of the neighboring groves. The species is evidently native to the Florida Peninsula, having been recorded, according to Pilsbry, 'Manual of Conchology,' Vol. 12, 1899, from the mouth of the St. Johns River south to the Caloosahatchee River. The snails appear to have found their way naturally into the groves of the Manatee region. Mr. F. D. Waite, manager of the Manatee Lemon Company, observed their presence on one or two trees in the Willis grove as early as the summer of 1903, and they seem to have appeared in other groves at about the same

[1] Saprophytic in the sense that, although following and directly dependent upon various living insects, sustenance is derived from waste products thrown off from the bodies of these insects.

[2] Kindly identified for the writer by Dr. W. H. Dall.

time. It was not until the summer of 1905, however, that their spread became conspicuous. The snails are active in the early morning while the trees are moist from the dew of the previous night. During the afternoon they gather in sheltered parts of the tree, or under pieces of sacks placed in the tree for the purpose, and are easily transferred in this way from grove to grove. Snails thus introduced into the Harrison grove at Palmetto in March increased in numbers rapidly and thoroughly cleaned the tree on which they were placed by mid-summer.

Considering the fondness of the snails for the injurious saprophytic fungus *Meliola*, it becomes of first importance to inquire into their treatment of the beneficial parasitic fungi. Among the fungi parasitic on orange insects five species in particular are of inestimable benefit to the orange grower. These are: the 'brown fungus'; the red-pink fungus, *Aschersonia aleyrodis* Webber; a bright red fungus, *Sphærostilbe cocophila* Tul.; the 'gray-headed' fungus, *Opheonectria cocicola* and the 'black fungus.' The first two fungi named are confined to the white fly larvæ; the remaining three are parasitic on the common bark scales of the orange. The brown fungus in its mature stages throws out silvery white hyphæ over the surface of the leaf, and these intertwining with those of the neighboring pustules not infrequently entirely cover the lower surface of the leaf. The snails occasionally feed to a limited extent on these spreading hyphæ, but not so far as observed on the hyphæ of the pustule. Considering the very limited extent to which the snails feed on the hyphæ, it seems probable the spread of the fungus will not be interfered with by the snails. The brown fungus is, as a matter of fact, very prevalent on the trees visited by the snails. The red-pink fungus throws out short hyphæ only; the snails, so far as observed, in no way interfere with this fungus. The red fungus, *Sphærostilbe*, is also apparently untouched, as it is found growing abundantly on the orange trees along with the snails. No opportunity has yet occurred to observe the behavior of the snails towards the gray fungus. The black fungus,[1] however, is found abundantly along with the snails and is apparently untouched by them.

White fly infestation has been severe in the Manatee region for not less than fifteen years, and for an equal or greater time throughout much of the region given by Pilsbry as within the range of *Bulimulus Dormani*. That the snails should be found in orange groves in the Manatee region alone and should have occurred there in sufficient numbers to attract attention or to clean foliage and fruit only within the past three years is suggestive of possible change in food habits of the Manatee River variety of the species, or of an unexplained temporary or permanent reduction of its natural enemies in that locality. During the past winter the snails have been given such protection as they seemed to require, and have been generally distributed throughout some of the large groves in order to further test their usefulness in cleaning up the 'sooty mold' fungus.

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University of Florida.

QUOTATIONS.

A NATIONAL DEPARTMENT OF HEALTH.

The government is designed for the welfare of the people, and in a government like ours, of the whole people, one of the first considerations in the people's welfare is their health; material resources are secondary. Without an able-bodied race, no country can prosper, and it is the favoring health conditions of the temperate zones that have made the races inhabiting them the rulers of the world. With the artificial conditions of civilization, however, the problem of the public health comes more and more to the front, and the old *laissez faire* methods show their deficiencies. More than one country at the present time is seeking methods and means to check the degenerative tendencies that threaten them, and the question whether our civilization is to last seems largely to depend on the success of these efforts.

[1] Recently identified as *Myriangium* sp., F. S. Earle, Ann. Rep. Office of Experiment Stations, 1903, pp. 457–8.

The paper of Professor Norton, published in this issue of *The Journal,* puts forth the economic side of the question as fully and fairly as any publication of its compass that has lately appeared. Coming from a non-medical man, it is an encouraging sign. Professor Norton shows how great a waste exists at the present time from preventable deaths, sickness and conditions of physical and mental inefficiency, due largely to the lack of a wise general governmental supervision. We have our pure food laws and our quarantine laws which go a certain way toward checking these evils, but they are, after all, only a beginning of what is needful. We have a great deal of government in regard to health matters, but it is local, unsystematized and often conflicting in different sections of the country and is distributed also, so far as it relates to national affairs, under different departments of the government, thus preventing the best results. The plea for a national department of health could be, to a certain extent, met by the consolidation under a single head of already existing bureaus without a great additional expense, but completeness and full efficiency would demand more than this.

The plan laid out by Professor Norton covers a much broader field, and, while it may not be absolutely realizable at once, the consolidation of the existing bureaus would be a great step in advance and could be enlarged on as wisdom and experience would dictate. The work done on less than a million and a half by the Public Health and Marine-Hospital Service is itself an indication of what a wise expenditure of only a moderate amount of public funds can accomplish. The protection of our southern coast from yellow fever, which it has practically accomplished, is worth annually many times the whole cost of that department, but this is a local service which principally benefits a section and not the whole country. An intelligent direction of health matters, including far more than that bureau at present has under its control, would be of still more widespread and general advantage. A considerable amount of the work done under the Agricultural Department, which is of the utmost value, including, for example, the admirable work of Dr. Wiley and that now assigned it under the pure food law, should properly be consolidated with the sanitary functions of other departments. Then a cabinet officer with expert knowledge of health matters could administer all these and other new departments to much better advantage than under the present system.—*The Journal of the American Medical Society.*

TECHNOLOGY—HARVARD GEOLOGICAL EXPEDITION.

DURING the past summer Professor Douglas Wilson Johnson, of Harvard University and the Massachusetts Institute of Technology, conducted a geological expedition through portions of New Mexico, Arizona and Utah. The expedition was supported by appropriations from both the Institute and Harvard University, together with contributions by several friends of the two institutions. Dr. H. W. Shimer, of the Institute geological department, and Mr. C. H. Decker, a graduate of the Columbia University School of Mines, were members of the party.

The first field work was done in New Mexico, where a week was spent in studying the geological relations of underground waters from the town of Belen eastward, while a week or more was devoted to a trip into the Mount Taylor volcanic district, where a somewhat extended detailed examination of the splendid volcanic necks was made.

The party then proceeded by rail to the Big Bug mining district, twenty-five miles southeast of Prescott, Arizona, where an outfit of wagons, horses and all necessary camp supplies was secured and final preparations made for an overland journey of twelve hundred miles, lasting from June 19 to September 10. Leaving Big Bug and crossing eastward to the Verde River, the ascent from the Basin Region to the Plateau Province was made near the head of Oak Creek, over what is known as the Mogollon Rim. Continuing north past Flagstaff, several days were spent in the San Francisco Mountain region, studying the glacial features in the main peak, and

the volcanic features associated with the more recent cinder cones and lava flows.

From here the party went to the Grand Canyon, making a three-days' trip down in the canyon with pack outfit, after which the journey eastward to the crossing of the Little Colorado and northward over the desert along the Echo and Paria cliffs, was begun. This proved to be the most strenuous part of the whole summer campaign, not so much because of lack of water—for which emergency due provision had been made—as because of the failure to secure sufficient feed for the five head of horses. From the Grand Canyon to the town of Kanab in southern Utah, a distance of more than 250 miles by the route traversed, the only grain available was a little corn at Tuba and one feed of oats at Lee's Ferry. The weather was intensely hot, the roads heavy with sand in many places, while grass fit for the horses to graze upon was only found at occasional places. As a result the horses got in poor condition, short days of travel and long rests were necessary, so that a large amount of time was consumed in this part of the journey. Kanab was reached on August 6.

From Kanab the party went north to Upper Kanab in order to visit the great terraces of the high plateaus of southern Utah. Returning to Kanab, a trip was then made to the southwest into the Toroweap Valley and the Mt. Trumbull region, for the purpose of tracing the relations of the Sevier and Toroweap faults, and the associated volcanic features. Returning as far as Pipe Spring, the party then turned westward, descending the Hurricane fault scarp west of Workman's Spring, and turning northward to the Virgin River. A delay of three or four days at this point was caused by a flood which was said to be the greatest ever known in the river's history.

Northward from the Virgin River the route passed along the margin of the Great Basin Province, at the foot of the western rim of the High Plateaus, through the towns of Toquerville, Beaver, Porowan, Holden, Nephi, etc. Good progress was made over splendid roads, notwithstanding frequent stops for side trips into many of the canyons which made possible a study of the northward continuation of the Hurricane fault, the character of the great Tertiary series and the volcanic beds, the undoubted evidence of recent faulting and other points of geologic and physiographic interest.

The outfit was sold in the towns of Provo and American Fork, just south of Salt Lake City. From the latter point Dr. Shimer went to the Yellowstone National Park for a few days, while Professor Johnson returned east by way of Butte, Montana. Mr. Decker will spend some time in the Bingham and Park City mining districts.

A detailed statement of the studies made in connection with the expedition, including reports on several special problems, will be published in the course of the winter.

PUBLICATIONS OF THE CARNEGIE INSTITUTION OF WASHINGTON.

THE Carnegie Institution of Washington has issued a circular of its publications, which are as follows:

Index Medicus: A monthly classified record of the current medical literature of the world. Second Series. Edited by Robert Fletcher, M.D., and Fielding H. Garrison, M.D.

Year Book No. 1, 1902. Octavo, 351 pages.

Year Book No. 2, 1903. Octavo, 371 pages.

Year Book No. 3, 1904. Octavo, 305 pages, 6 plates.

Year Book No. 4, 1905. Octavo, viii + 303 pages, 7 plates.

No. 1. The Carnegie Institution of Washington, D. C. Octavo, 16 pages.

No. 2. Articles of Incorporation, Deed of Trust, etc. Octavo, 15 pages.

No. 3. Proceedings of Board of Trustees. Octavo, 15 pages. [The matter contained in Nos. 1, 2 and 3 is embodied in Year Book No. 1.]

No. 4. The Waterlilies: A monograph of the Genus Nymphæa. By Henry S. Conrad. Quarto, xiii + 279 pages, 82 text figures, 30 plates, including 12 plates colored to life.

No. 5. Catalogue of Double Stars. By S. W. Burnham. Quarto. In press.

No. 6. Desert Botanical Laboratory of Carnegie Institution. By F. V. Coville and D. T. MacDougal. Octavo, vi + 58 pages, 29 plates.

No. 7. New Method of Determining Compressibility. By T. W. Richards and W. N. Stull. Octavo, 45 pages, 5 text figures.

No. 8. Bibliographic Index of North American Fungi. By W. G. Farlow. Octavo. Vol. 1, part 1, xxxv + 312 pages.

No. 9. The Collected Mathematical Works of G. W. Hill. Quarto, 4 vols. Vol. 1, xviii + 363 pages; Vol. 2, vii + 339 pages; Vol. 3, 577 pages. Vol. 4 in press.

No. 10. Contributions to Stellar Statistics. On the Position of the Galactic and Other Planes Toward Which the Stars Tend to Crowd. By Simon Newcomb. Quarto, 30 pages.

No. 11. Production of Sex in Human Offspring. By Simon Newcomb. Octavo, 34 pages.

No. 12. The Action of Snake Venom upon Cold-blooded Animals. By Hideyo Noguchi. Octavo, 16 pages.

No. 13. Influence of Grenville on Pitt's Foreign Policy, 1787–1798. By E. D. Adams. Octavo, 79 pages.

No. 14. Guide to Archives of the Government at Washington. By C. H. Van Tyne and W. G. Leland. Octavo, xiii + 215 pages.

No. 15. Fecundation in Plants. By D. M. Mottier. Octavo, viii + 187 pages, 75 text figures.

No. 16. Contributions to the Study of the Behavior of the Lower Organisms. By H. S. Jennings. Octavo, 256 pages, 81 text figures.

No. 17. Traditions of the Arikara. By G. A. Dorsey. Octavo, 202 pages.

No. 18. Researches on North American Acridiidæ. By Albert P. Morse. Octavo, 56 pages, 8 plates.

No. 19. Coloration in Polistes. By Wilhelmine M. Enteman. Octavo, 88 pages, 6 colored plates, 26 text figures.

No. 20. The Coral Siderastrea radians. By J. E. Duerden. Quarto, v + 134 pages, 11 plates, 13 text figures.

No. 21. Mythology of the Wichita. By G. A. Dorsey. Octavo, viii + 351 pages.

No. 22. Report on the Diplomatic Archives of the Department of State, 1789–1840. By A. C. McLaughlin. Octavo, 73 pages.

No. 22. Revised edition.

No. 23. Heredity of Coat Characters in Guinea Pigs and Rabbits. (Paper No. 1, Station for Experimental Evolution.) By W. E. Castle. Octavo, 78 pages, 6 plates, 8 text figures.

No. 24. Mutants and Hybrids of the Oenotheras. (Paper No. 2, Station for Experimental Evolution.) By D. T. MacDougal, assisted by A. M. Vail, G. H. Shull and J. K. Small. Octavo, 7 pages, 22 plates.

No. 25. Evolution, Racial and Habitudinal. By J. T. Gulick. Octavo, xii + 269 pages, 5 plates.

No. 26. Exploration in Turkestan. By Raphael Pumpelly, W. M. Davis, R. W. Pumpelly and Ellsworth Huntington. Quarto, xii + 324 pages, 6 plates, 174 text cuts.

No. 27. Bacteria in Relation to Plant Diseases. By Erwin F. Smith. Quarto, xii + 285 pages, 31 plates, 146 text cuts.

No. 28. A Revision of the Atomic Weights of Sodium and Chlorine. By T. W. Richards and R. C. Wells. Octavo, 70 pages.

No. 29. The Color Sensitivity of the Peripheral Retina. By J. W. Baird. Octavo, 80 pages.

No. 30. Stages in the Development of Sium cicutaefolium. (Paper No. 3, Station for Experimental Evolution.) By G. H. Shull. Octavo, 28 pages, 7 plates, 11 text cuts.

No. 31. The Isomorphism and Thermal Properties of the Feldspars. Part I., Thermal Study; by A. L. Day and E. T. Allen. Part II., Optical Study; by J. P. Iddings. (With an introduction by G. F. Becker.) Octavo, 95 pages, 25 text cuts, 26 plates.

No. 32. Chimaeroid Fishes and their Development. By Bashford Dean. Quarto. In press.

No. 33. Researches in Stellar Photometry. By J. A. Parkhurst. Quarto. In press.

No. 34. American Fossil Cycads. By G. R. Wieland. Quarto. vii + 296 pages, 51 plates, 141 figures.

No. 35. Investigations of Infra-red Spectra: Part I., Infra-red Absorption Spectra; Part II., Infra-red Emission Spectra. By W. W. Coblentz. Octavo, 331 pages, 152 figures.

No. 36. Studies in Spermatogenesis with especial reference to the 'Accessory Chromosome.' By N. M. Stevens. Octavo, 32 pages, 7 plates.

No. 36. Studies in Spermatogenesis, Part II. By N. M. Stevens. Octavo. In press.

No. 37. Sexual Reproduction and the Organization of the Nucleus in certain Mildews. By R. A. Harper. Octavo, 104 pages, 7 plates.

No. 38. Writings on American History, 1903. Prepared under direction of A. C. McLaughlin. Octavo, 172 pages.

No. 39. Handbook of Learned Societies. Octavo. Vol. 1 (North and South America). In press.

No. 40. The Nucleation of the Uncontaminated Atmosphere. By Carl Barus. Octavo, xii + 152.

No. 41. Traditions of the Caddo. By G. A. Dorsey. Octavo, 136 pages.

No. 42. A Respiration Calorimeter with Appliances for the Direct Determination of Oxygen. By W. O. Atwater and F. G. Benedict. Octavo, 193 pages, 49 figures.

No. 43. Observed Position of Sun Spots. By C. H. F. Peters. (Edited by E. B. Frost.) Quarto. In press.

No. 44. Researches in Experimental Phonetics. Recording, Tracing, Measuring and Analyzing Speech Vibrations. By E. W. Scripture. Quarto. In press.

No. 45. Catalogue of Stars within two degrees of the North Pole, deduced from Photographic Measures. By Caroline E. Furness. Octavo, 85 pages.

No. 46. An Investigation into the Elastic Constants of Rocks, especially with reference to their Cubic Compressibility. By F. D. Adams and E. G. Coker. Octavo, 69 pages, 16 plates.

No. 47. Pulsation of Scyphomedusae. By A. G. Mayer. Octavo. In press.

No. 48. An Investigation of Evolution in Chrysomelid Beetles of the Genus Leptinotarsa. (Paper No. 4, Station for Experimental Evolution.) By W. L. Tower. Octavo. In press.

No. 49. Heredity of Hair-lenth in Guinea-pigs, and its Bearing on the Theory of Pure Gametes. By W. E. Castle and Alexander Forbes. (Paper No. 5, Station for Experimental Evolution.) The Origin of a Polydactylous Race of Guinea-pigs. (Paper No. 6, Station for Experimental Evolution.) By W. E. Castle. Octavo, 29 pages.

No. 50. The Relation of Desert Plants to Soil Moisture and to Evaporation. By Burton E. Livingston. Octavo, 78 pages, 16 text cuts.

No. 51. Studies on the Germ Cells of Aphids. By N. M. Stevens. Octavo, 28 pages, 4 plates.

No. 52. Inheritance in Poultry. (Paper No. 7, Station for Experimental Evolution.) By C. B. Davenport. Octavo, 136 pages, 17 plates.

No. 53. Egyptological Research. By W. Max Müller. Quarto, 62 pages, 106 plates.

No. 54. Research in China. By Bailey Willis. Quarto. In press.

No. 55. A Revision of the Pelycosauria of North America. By E. C. Case. Quarto. In press.

No. 56. The Energy Changes involved in the Dilution of Zinc and Cadmium Amalgams. By T. W. Richards and G. S. Forbes. Octavo. In press.

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No. 61. Changes in Free Energy of Iron under Varying Conditions, and the Occlusion of Hydrogen by Iron. By T. W. Richards and G. E. Behr. Octavo. In press.

No. 62. Condensation of Vapor as induced by Nuclei and by Ions. By Carl Barus. Octavo. In press.

No. 63. The Electrical Conductivity of Aqueous Solutions. By Arthur A. Noyes and others. Octavo. In press.

INSANITY IN ENGLAND AND WALES.[1]

According to the Sixtieth Report of the Commissioners in Lunacy for England and Wales, recently issued, the number of certified insane persons under care on January 1, 1906, in England and Wales was 121,979, of whom 9,802 were private patients, 111,256 pauper patients and 921 criminal lunatics. Of the total number, 89,342 were maintained in county and borough asylums, 17,742 in workhouses and metropolitan district asylums, 7,973 in registered hospitals, licensed houses and in naval and military hospitals, 776 were in the criminal lunatic asylum at Broadmoor, 528 were private single patients and there were 5,618 outdoor pauper lunatics.

The report shows a total increase in the number of the certified insane of 2,150 over the numbers of the previous year. This increase compares favorably with the increments of the three previous years, which were 2,630 for 1904, 3,235 for 1903 and 3,251 for 1902. Further, it is less by 404 than the annual average increase for the decennium ending December 31, 1905, namely, 2,554, and less by 657 than the average increase for the latter half of this decennium, namely, 2,807. Compared with 1904 the private patients have increased by 162, the criminal lunatics by 9 and the pauper patients by 1,979, the increase in the private patients being greater by 79, but the increase of the criminal lunatics being less by 26 and that of the pauper patients by

[1] From the *British Medical Journal.*

527, than in 1904. This shrinkage in the increase of pauper and criminal insanity, small though it may be, is highly satisfactory, and this is supported by the fact that in county and borough asylums the proportion of private patients to the total number therein has risen from 2.7 to 2.8 per cent. during the year. As to the fluctuations of pauper insanity in counties and boroughs the commissioners say that, as compared with the previous year, there has been in the 63 administrative counties a net increase in 40 counties amounting to 1,360 in all. In 20 counties there has been a net decrease amounting to 166, and in three counties —Hereford, Rutland and Somerset—neither increase nor decrease. London County shows by far the largest increase, amounting to 305. Middlesex, Essex, Kent, Surrey and the West Riding of Yorkshire, also show considerable increases. Of the 72 county boroughs an increase, amounting to 769 in all, occurred in 54, a decrease amounting to 109 in 14, and in 3—Chester, Hastings and South Shields—neither increase nor decrease. Of the 19 boroughs 11 showed an increase, amounting to 70 in all; in 7 there was a decrease, amounting in all to 31, and in 1 borough there was neither increase nor decrease.

Turning to the general question of the increase of insanity since 1859, the total number of certified insane has risen from 36,762 to 121,979, a rate of increase equivalent to 231.8 per cent., the general population having increased during the same interval at the rate of 75.4 per cent. Taking only the past ten years, there has been during that period a total increase of the certified insane of 26.5 per cent. This increase, however, is, as is shown by a table furnished by the commissioners, not only variable, but steadily declining—that is, the increase has been mounting more slowly for some years. Corresponding to this absolute increase, the ratio of the insane to population is increasing at a lessened rate. On January 1, 1906, the total certified insane in England and Wales stood to the estimated population in the proportion of 1 to 283, as contrasted with 1 to 285 of last year, 1 to 288 of 1903 and 1 to 314 of ten years ago—that is, the proportion of insane persons to the community, per 10,000, has risen from 31.89 to 35.31 during the decade. The increase in population during this period has been 10.8 per cent., and in the total number of insane under care 22.7 per cent. Thus, the number of insane persons under care, both numerically and relatively to population, is still steadily increasing, though, of course, this is not necessarily indicative of an increasing growth of actual occurring insanity. To this point we shall refer later. From the point of view of the ratepayers, however, this increase may be taken as an actual increase of insanity, particularly as the increase is practically confined to the pauper class. This is clearly brought out by Chart II., facing p. 6, showing the comparative variations in the proportion of the insane to total population from 1859 to 1906. In 1859 the ratio of private patients per 10,000 population was 2.38. This rose in 1879 to 2.97, then fell to 2.67 per 10,000 in 1897, since when it has risen slowly, and—with the exception of last year, when there was a drop of 0.01 per 10,000—steadily, to the present proportion of 2.84 per 10,000. The ratio of pauper lunatics, on the other hand, has risen without intermission from the 15.95 per 10,000 of 1859 to the present figure, for January 1, 1906, of 32.20 per 10,000. Doubtless the question of an actual increase of insanity is insoluble by purely statistical methods; but of these latter, the occurrence of insanity, as shown by the ratio of first admissions to population, furnishes the most reliable index. The commissioners' report does not contain information respecting this ratio for the years prior to 1898; but Table III., Appendix A, shows that in 1898 this ratio per 10,000 population was 4.92. This increased steadily to 5.76 in 1902, and since then has declined to 5.21, the ratio for 1905. Thus, so far as statistical evidence goes, these figures tend to show that for the last four years occurring insanity has not been on the increase relatively to population, and that the considerable absolute and relative increase of insane persons under care is to be explained by accumulation consequent on increasing

longevity of asylum inmates, increased certification, and so on.

THE LOWELL LECTURES.

Lectures under the Lowell Institute, Boston, are announced as follows:

The first course will be eight lectures by Percival Lowell, non-resident professor of astronomy at the Massachusetts Institute of Technology, director of the Lowell observatory, Flagstaff, Ar., and medalist (Mars) of the French Astronomic Society, on 'Mars as the Abode of Life.' (1) 'Planetary Evolution: the Conditions and Possibilities of Life.' (2) 'Natural Features of Mars.' (3) 'Geology and Areology: Mars and Glacial Epochs.' (4) 'Geology and Areology: Loss of Oceans and Growth of Deserts.' (5) 'Habitability: Probability of Life on Mars.' (6) 'Non-Natural Features: Canals and Oases.' (7) 'Metamorphoses of the Canals.' (8) 'Habitation: the Proofs of Life on Mars.' On Mondays and Thursdays, at 8 P.M., beginning October 15.

The second course will be eight lectures (in French) by M. le Dr. Pierre Janet, professeur de psychologie au Collége de France, directeur du laboratoire de psychologie de la Salpêtrière, on 'Psychotherapeutics or the Applications of Psychology to Therapeutics' (La psychothérapie, les applications de la psychologie à la thérapeutique). (1) 'Résumé Historique.' (2) 'Principe de la Psychothérapie. Influence des Etats Psychologiques sur la Santé Physique et Morale.' (3) 'Psychothérapie Générale, L'Exhortation Morale.' (4) 'Les Méthodes Suggestives.' (5) 'Les Méthodes D'Isolement et de Repos.' (6) 'L'éducation Motrice.' (7) 'L'éducation de la Sensibilité, l'Æsthésiogénie.' (8) 'Le Relèvement de la Tension Psychologique l'Education de l'émotivite.' On Tuesdays and Fridays, at 8 P.M., beginning October 23.

The third course will be eight lectures by Barrett Wendell, professor of English in Harvard University, on 'Contemporary France.' (1) 'The Universities.' (2) 'The Structure of Society.' (3) 'The Family.' (4) 'The French Temperament.' (5) 'The Relation of Literature to Life.' (6) 'The Question of Religion.' (7) 'The Revolution and Some of Its Effects.' (8) 'The Republic and Democracy.' On Mondays and Thursdays, at 8 P.M., beginning November 12.

The fourth course will be eight lectures by William James, professor of philosophy in Harvard University, on "The Movement Called 'Pragmatism' in Recent Philosophy." On Wednesday and Saturdays, at 8 P.M., beginning November 14.

The fifth course will be eight lectures by Alfred C. Haddon, Sc.D., F.R.S., university lecturer in ethnology, Cambridge, England, on 'The Melanesians: Racial Problems, Distribution of Culture, Social and Religious Evolution.' On Tuesdays and Fridays, at 8 P.M., beginning November 20.

The sixth course will be two lectures by William H. Furness, 3d, M.D., F.R.G.S., fellow of the Anthropological Institute of Great Britain and Ireland, etc., on 'The Kayan and Kenyah Tribes of Borneo, and the Natives of Uap in the Caroline Islands.' On Monday, December 10, and Thursday, December 13, at 8 P.M.

The seventh course will be eight lectures by Professor George E. Woodberry, on 'Poetic Energy.' On Tuesdays and Fridays, at 8 P.M., beginning January 8, 1907.

The eighth course will be eight lectures by Colonel Sir Colin Scott Moncrieff, LL.D., knight commander of the Star of India, etc., on 'The English in India and Egypt.' On Mondays and Thursdays, at 8 P.M., beginning February 4.

The ninth course will be eight lectures by Frank M. Chapman, curator of ornithology, American Museum of Natural History, New York City, on 'The Distribution of North American Birds.' On Tuesdays and Fridays, at 8 P.M., beginning February 5.

The tenth course will be six lectures by Charles Sedgwick Minot, D.Sc., LL.D., etc., James Stillman professor of comparative anatomy in the Harvard Medical School, on 'The Problem of Age, Growth and Death.' On Mondays and Thursdays, at 8 P.M., beginning March 4.

The eleventh course will be eight lectures

by Russell H. Chittenden, LL.D., professor of physiological chemistry and director of the Sheffield Scientific School of Yale University, on 'The Nutrition of Man.' On Tuesdays and Fridays, at 8 P.M., beginning March 5.

The twelfth course will be eight lectures by Albert Bushnell Hart, LL.D., professor of history in Harvard University, on 'The Real South.' On Mondays and Thursdays, at 8 P.M., beginning March 25.

SCIENTIFIC NOTES AND NEWS.

SIR WILLIAM PERKIN was entertained at a banquet at Delmonico's on October 6. Professor Charles F. Chandler presided and a number of speeches were made. Dr. Hugo Schweitzer read a paper describing the extraordinary chemical advances that had followed the discovery of mauve by Sir William Perkin fifty years ago. Dr. William H. Nichols presented the first impression of a gold medal established in honor of Sir William, which will be awarded each year for the most important discovery in applied science. A silver tea set was presented by Mr. Adolf Kuttroff and honorary membership in the American Chemical Society by its president, Dr. W. F. Hillebrand. Among other speakers were President Nicholas Murray Butler, Dr. H. W. Wiley and Professor Walther Nernst. Sir William Perkin replied, giving a most interesting account of his work in chemistry.

PROFESSOR S. F. EARLE has resigned the directorship of the Cuban Central Agricultural Station, which was organized in 1902.

DR. H. C. WOOD, for thirty years professor of therapeutics in the University of Pennsylvania and until 1902 clinical professor of diseases of the nervous system, has retired from the active duties of his chair, and has been made professor emeritus.

AT the recent Quebec Congress of Americanists, the following resolution was passed: "The International Congress of Americanists has learned with great regret that Dr. Albert S. Gatschet has been compelled to give up the continuation of his important investigations which he has carried on for many years, and expresses its admiration for the great services which he has rendered to Americanistic studies, particularly to those of Indian languages and of the ethnography of North America."

DR. HARRY FIELDING REID, professor of geological physics in the Johns Hopkins University, has sailed for Rome as the representative of the United States at the annual meeting of the International Seismographic Association.

AMONG the delegates to the celebration of the four hundredth anniversary of the foundation of the University of Aberdeen the following were mentioned in *Nature:* Professor H. Becquerel, Professor Behring, Dr. C. De Candolle, Professor Deissmann, Professor Yves Delage, Dr. Anton Dohrn, Professor A. Giard, Professor H. Höffding, Professor F. Hueppe, Professor Jensen, Professor Lombroso, Professor Matsumura, Professor Mendeléeff, Professor Menschutkin, Professor Hugo Münsterberg, Professor W. Ostwald, Professor Giuseppe Veronese, Professor Paul Vinogradoff, Professor J. W. Wijhe and Professor Weichselbaum.

DR. ARNOLD JACOBI, professor of zoology at the School of Forestry at Tharandt, has been appointed director of the Zoological and Ethnological Museum at Dresden, in succession to Dr. A. B. Meyer.

DR. A. PACZ, sometime private assistant to Professor Baskerville, has become chief chemist to the National Electric Lamp Company, Cleveland, Ohio.

MR. E. F. SCHRAMM, A.B. (Oklahoma, '06), who was elected to a fellowship in geology in the University of Nebraska, has had charge during the past season of a field party of the Morrill geological expedition under the direction of Professor E. H. Barbour, collecting Tertiary vertebrates in the Nebraska bad lands.

MR. CUSTER A. REED, A.B. (Oklahoma, '06), who is doing graduate work in paleontology at Yale, spent the greater part of the season studying water-supply conditions near East St. Louis for the Illinois Geological Survey.

DR. JAMES C. WELLS, adjunct professor of analytical chemistry at Columbia University,

has been given leave of absence for the coming year.

Dr. Philip P. Calvert, of the department of zoology, University of Pennsylvania, and Mrs. Calvert have just returned from a six weeks' tour in Mexico, where they collected information on the distribution of the Odonata on the northern part of the central plateau. These data will be incorporated in Dr. Calvert's section on the Odonata, now nearly finished, in the *Biologia Centrali-Americana,* edited by Mr. F. D. Godman, F.R.S. As members of the International Geological Congress, Dr. and Mrs. Calvert participated in the sessions of that body, at Mexico City, in September last.

Dr. W. B. Huff has resumed his work as head of the department of physics at Bryn Mawr College after a year spent at the Cavendish Laboratory, Cambridge.

Dr. O. Tetens, of the Samoa Observatory, has been appointed assistant in the Kiel Observatory.

Professor Neisser, of Breslau, expects to return next month to Java, to continue the experiments on syphilis.

Dr. John A. Brashear, of Pittsburg, will give the address at Lehigh University on Founder's Day, to be celebrated on October 11.

Professor Charles Baskerville, of the department of chemistry of the College of the City of New York, will give a course of six lectures on 'The Elements' in the Brooklyn Institute of Arts and Sciences every Tuesday evening from October 16 to November 27.

Professor A. E. Outerbridge, Jr., opened the meetings of the section of mining and metallurgy of the Franklin Institute, Philadelphia, on October 4, with a paper entitled 'Recent Progress in Metallurgy.'

Dr. Andreas Högyes, professor of pathology at Buda Pesth and founder of the Pasteur Institute in that city, has died at the age of sixty years.

The Chicago Academy of Sciences received $100,000 under the will of W. Moses Willner.

Under the name of Georg und Franziska Speyer-Haus, there has been established at Frankfort-on-Main a chemico-therapeutic institute, which has been placed under the direction of Dr. Paul Ehrlich.

We learn from *The British Medical Journal* that an institution bearing the name of 'Laboratoire Biologique du Radium' has been at work in Paris since July 1 under the direction of Dr. Louis Wickham, surgeon to St. Lazare. It is intended for the study of radium and its applications to medicine. The institution, thanks to the munificence of a wealthy manufacturing chemist, M. Armet de Lisle, is equipped on a lavish scale. It comprises a physical laboratory; a chemical laboratory; a laboratory of experimental medicine, pathology and bacteriology, and a clinical department, partly for gratuitous, partly for paying patients. Already, it is said, some interesting therapeutic results have been obtained.

A plea for the preservation of natural scenes and objects in Germany was put forward, says *Nature,* two years ago by Professor H. Conwentz, director of the West Prussian Provincial Museum at Danzig, in a work on 'Naturdenkmäler.' By Naturdenkmäler is meant the whole natural landscape, with its various soil formations, its water courses and lakes, its special plant and animal communities, as well as single rare species and individuals of the original flora and fauna. Professor Conwentz proposed that these results of nature's handiwork in the different states of the German empire should be placed on record so as to make them known, and that provision should be made for their protection. The Prussian minister of instruction has just consented to the establishment of a central office for this purpose. For the present the office will be at Danzig, and will be under the direction of Professor Conwentz.

On account of strikes and other delays, caused by the ventilation contracts, the completion of the new chemical laboratory of the College of the City of New York has been delayed. It is hoped to open the laboratory formally some time in the winter.

At the Harvard College Observatory a telegram has been received from Professor W. W.

Campbell, at Lick Observatory, stating that the seventh satellite of Jupiter was reobserved by Perrine Sep. 25.9962 G. M. Y. Its position angle was 119.1° and its distance was 2578″.

WE learn from *The Auk* that the annual meeting of the Maine Ornithological Society will be held at the rooms of the Portland Society of Natural History, Portland, Maine, on Friday and Saturday following Thanksgiving day.

THERE will be a civil service examination on November 14, to fill the position of aid (male) in zoology, in the department of biology of the U. S. National Museum at a salary of $720; there will also be a civil service examination on November 7 and 8 for topographic draftsman on the Isthmus of Panama, at salaries of $100 and $125 a month.

AT the meeting of the 'Conference on Home Economics' held at Lake Placid during the second week of September a letter was read from Mr. LeBosquet proposing that the Public Health and Marine Hospital Service should issue popular bulletins for the information of the public on health matters. Extracts from the letter proposing a National Board of Health were read. The conference voted that its secretary should communicate with President Roosevelt expressing the approval of the conference both of the plan for the distribution of circulars of information by the Public Health and Marine Hospital Service and for the establishment of a National Department of Health to coordinate and extend the work already being done by the national government. At this conference Professor Irving Fisher, of Yale University, presented the results of experiments made at Yale University during the last college year directly to ascertain the effect of change of diet upon working power. The experiment was conducted on nine healthy students who volunteered for the purpose and was based upon the previous experiments of Professor Chittenden. After four and a half months it was found that the men on the average had doubled their physical endurance, as shown by gymnasium tests, which they had at the beginning of the experiment in January. This great increase is ascribed entirely to dietetic causes, as no other factors which were likely to increase endurance were known to be present. The change in diet was not through any food prescription, but was brought about by following in an entirely natural manner three rules, the first two of which are Mr. Fletcher's; first, thorough mastication of food, with the attention on the taste and enjoyment of food, not on the mechanical act of mastication; second, implicit obedience to the appetite, both in regard to the kind of foods consumed and quantity; third, when appetite consented, but not otherwise, the fullest benefit of the doubt was given to low proteid foods rather than meats and other high proteid foods. At the end of the experiment the men had reduced their proteid to about the level shown by Professor Chittenden to be the normal required.

AN interesting address on educational methods and their relation to science and industry, with particular reference to pottery, was delivered by Professor H. E. Armstrong in the Town Hall, Longton, on September 19. In the course of his remarks, according to an abstract in *Nature*, he said that workers in science have evolved a method, the scientific method, involving the gradual and cautious passage from the known to the unknown. Workers in politics have no such method at their disposal. Too often they are more or less ignorant of the real nature and extent of the problems which they deal with and seek to solve; sentiment masters their actions. The application of scientific method to public affairs is, consequently, becoming a matter of paramount importance. In all manufacturing districts science and industry must be brought into an effective alliance. On no other basis are prosperity and happiness possible, for the simple reason that, in these days, an industry that does not repose on a scientific basis is one which has no proper knowledge of itself, science being nothing more than organized systematic knowledge. Scientific training, training in method, is required by all. Scientific knowledge, true knowledge, must be public possession. The feeling is becoming general that

something must be done to make our schools more effective than they are. In a recent report of the Consultative Committee, the Board of Education is advised that the schools have failed, in the past, to develop both the moral and mental qualities which are desirable, and that we must now strive to make the teaching far more practical, manual training being openly and strongly advocated. We read, moreover, "It would seem clear to the committee that the thing needed is not only knowledge, but a right attitude of mind, a mind confident in its own power to observe and think, and in the habit of observing and thinking—a mind in which interest makes for intelligence and intelligence for interest." "The course," it is stated, "should consist of three threads or strands, roughly to be termed humanistic, scientific and manual, and, in the case of girls, domestic; all higher elementary schools should give this threefold instruction." Though these views have been urged by many educational reformers for thirty years or more, the doctrine they involve is really quite revolutionary coming from such a quarter, especially as it is directed to the Board of Education, which treats manual training as a special subject for the select few.

UNIVERSITY AND EDUCATIONAL NEWS.

THE new building for the engineering department of the University of Pennsylvania will be dedicated on October 19.

THE Princeton correspondent of the *Evening Post* writes: "The handsome new faculty room in Nassau Hall is now completed, and the university faculty holds its meetings there. The room is finished in old English quartered oak panelling, and the faculty, when in session, are seated on long benches on each side of the room, facing each other, after the manner of the seating of the English House of Commons. The room has been refitted from a fund left by the late Augustus Van Wickle, a descendant of Nathaniel Fitz Randolph, who gave the original Princeton campus, on which Nassau Hall is situated. This hall is eventually to become the administrative building of the university, the offices of administration to be grouped about the main faculty room. It was in the room now used by the faculty that Congress met for five months in 1783, Nassau Hall being at that time the capitol of the new republic. In the historic room a special audience was given to Washington; there also the minister of the Netherlands, General Lafayette and nearly all the prominent public men of America were received."

DR. JAMES BARNES, instructor in physics at the Johns Hopkins University, has been appointed associate in physics at Bryn Mawr College.

THE following promotions and appointments have been made in the chemical department of the College of the City of New York: Assistant Professor H. R. Moody, Ph.D., to be associate professor in charge of analytical chemistry; Instructor L. H. Friedburg, Ph.D., to be assistant professor in charge of organic chemistry; Mr. Reston Stevenson, M.S. (North Carolina), formerly assistant in Cornell University, to be tutor in analytical chemistry; Mr. W. A. Whitaker, Jr., M.S. (Columbia), to be tutor in general chemistry; and Mr. Lorenz Sporer, B.S. (Hobart), to be assistant tutor in the same subject.

AT Boston University Assistant Professor Arthur W. Weysse and Lyman C. Newell have been made professors of biology and of chemtry, respectively.

PROFESSOR GEORGE V. N. DEARBORN, of Tufts College, has been appointed lecturer and instructor in the relations of body and mind in the Sargent School of Physical Education, Cambridge.

DR. G. HAUSER, professor of pathology at Erlangen, has declined a call to Würzburg, in succession to Dr. von Rindfleisch.

AT University College, London, the following appointments have been made: Mr. A. Wolf, D.Litt., assistant professor of philosophy; Mr. V. H. Blackman, M.A., lecturer in plant cytology in the department of botany; Mr. N. G. Dunbar, demonstrator in the department of applied mathematics; Messrs. E. Foxell, W. H. Gibson and H. E. Watson, assistant demonstrators in the department of chemistry.

SCIENCE

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THE JUBILEE OF THE COAL TAR COLOR INDUSTRY.
THE INFLUENCE OF SIR WILLIAM HENRY PERKIN'S DISCOVERY UPON OUR SCIENCE.[1]

I NEED hardly assure you how highly honored I feel to be permitted to speak here to-night. Yet I am fully aware that the committee did not select me because it considered me the most competent of our chemists to respond to this subject, but because so many of our colleagues refused to be heard, fearing the arduous labor of condensing this vast material within the limits of a fifteen-minute address, when fifteen hours could be devoted to it with much less difficulty and work. With me, however, it was a labor of love, and I accepted with pride and pleasure, inspired by the wonderful development of this industry in which I have been an attentive watcher and a modest coworker, it being just twenty years since, in collaboration with Professor Bernthsen, I began the investigations which finally culminated in the discovery of the constitution of the dyestuffs of the safranine series. Above all, I have been inspired in my task by the genial personality and refined modesty of our distinguished guest, Sir William Henry Perkin, with whom I had the pleasure of becoming more intimately acquainted during last year's meeting of the Society of Chemical Industry in London. It must be a sincere source of congratula-

[1] Given at the banquet given to Sir William Henry Perkin, at Delmonico's, New York City, October 6, 1906.

tion to us that he has braved the perils of a long ocean voyage to honor us with his presence at our celebration of the semi-centennial of the coal tar industry, initiated by the discovery of Perkin's mauve. Only fifty years ago, while engaged in research, having for its object the artificial production of quinine, Perkin, then an eighteen-year old assistant of Hofmann, obtained a muddy, dark precipitate, from which he first endeavored to extract certain colorless crystalline substances which might adequately explain the reaction under observation. One day, however, the thought occurred to him to utilize this colored precipitate itself for the dyeing of silk. It is hard to realize to-day what an epoch-making idea it was at that time to dye fabrics with a substance evolved in the laboratory and having no relation whatever to the dyestuffs then known. It was truly the spark of genius which led Perkin to investigate the dyeing properties of that dark-colored precipitate which would have been cast away by any other scientist of that period and particularly by his master, Hofmann, who objected to experimenting with anything which did not crystallize and who had at that time a strong aversion to working with substances which were colored. For the latter, when produced in reactions, were generally regarded as secondary products and every endeavor was made to get rid of them, so that the other substances associated with them might be examined.

But however great the discovery of mauve, and however much we must admire the courage of the youth who undertook its technical production, yet these steps were only trivial incidents in the immense revolution brought about by Perkin's genius. The greatest obstacles encountered by him, and the most difficult task to be performed, was when he attempted to sell the color to dyers and printers. At that time men of this class worked by the rule of thumb with secret recipes, mostly inherited from their forefathers, and their formulæ, although applicable to natural colors, were not suitable for mauve. Thus Perkin and his associates had to prepare new directions for dyeing and printing and to induce those ultra conservative dyers to adopt the new methods. It has been almost forgotten that Perkin was the first to introduce the method of dyeing silk in a soap bath which is commonly employed to-day for all artificial dyestuffs, and that he and Pullar first made use of the mordanting of cotton with the insoluble inorganic compounds of tannin.

Thus the introduction of mauve completely changed the art of dyeing and printing, simplifying the processes and substituting for the old time formulæ the scientific recipes furnished by the color manufacturers of the present day. After Perkin had thus removed the obstacles in the path of practical application, it became comparatively easy to introduce other coal tar colors.

But Perkin also paved the way for the discovery of the later coal tar colors by creating commercially aniline and benzole, which up to his time had only been laboratory curiosities. Of the three methods available for obtaining aniline he selected as the most promising the reduction of nitrobenzol, made by nitration of coal tar benzol, and the production of aniline from this source led, shortly after the discovery of mauve, to the discovery of magenta, which opened up a new and immense field for this industry. Aniline from benzole was later found to contain toluidine, which is not present in aniline from indigo or that obtained directly from coal tar, and Perkin truly said in a lecture delivered December 7, 1868:

> Had the aniline contained in coal tar or the aniline obtained from indigo been employed for the preparation of mauve, instead of that pre-

pared from commercial benzol, magenta and its train of colored derivatives would in all probability have remained unknown to the present day from the simple fact that magenta can not be produced from pure aniline, a second body being also required.

The industry thus initiated with a violent impetus soon showed its revolutionizing tendencies and its vitalizing power in almost every branch of human endeavor. To-day about 2,000 individual dyestuffs are known, giving the whole range of the colors of the rainbow, and complying with every demand of taste, fashion and stability. They surpass in beauty and brilliancy the colors supplied by nature, and, contrary to the impression prevailing among the public, the shades obtained with some of them are faster to the influence of time, light and chemicals than the fastest which nature produces.

The greatest triumph of this branch of the industry was the artificial production of alizarine and indigo. In the technical production of the former our distinguished guest has played a prominent part, solving the problem of its manufacture simultaneously with Graebe, Liebermann and Caro, whose English patent antedates that of Perkin by one day, and for the first synthesis of indigo cinnamic acid was successfully employed which was originally obtained from coal tar by Perkin.

Coal tar colors, however, are not only used for the dyeing of textile fibers, like wool, silk, cotton, linen, jute, ramie, etc., but for a host of other materials.

The lady's hair is gray, or of a hue not fashionable at the time—coal tar colors will assist her in appearing youthful and gay. In eating the luscious frankfurter your soul rejoices to see the sanguineous liquid oozing from the meat—alas coal tar colors have done it, and friend Wiley can prove it. The housewife selects a bright green broom, on account of its anticipated good wearing quality, but finds, to her sorrow, that coal tar colors furnished the freshness. The product of the hen is replaced by yellow coal tar colors in custard powders, and butter is colored yellow when the dyestuff laboratory of the cow is on a strike. Leather, paper, bones, ivory, feathers, straw, grasses, are all colored, and one of the most interesting applications is the dyeing of whole pieces of even the bulkiest furniture by dipping them in large tanks containing the dyestuffs, which transforms the wood into walnut, mahogony at your command, as carried out in our big factories in Grand Rapids and elsewhere.

As coal tar colors are used on this enormous scale, so they are also employed in a liliputian manner, for staining specimens for examination under the microscope, enabling us to detect and identify bacteria, the finest nerve-ends and other minute elements of animal tissues, and by means of such staining methods, especially with methylene blue, Koch discovered the bacillus of tuberculosis and cholera, and initiated the modern battle against preventable infectious diseases. In reciprocation for the excellent reagents supplied him by the dye industry, the histologist brought about the discovery of a new and very important class of colors, and as this instance is one of the most striking demonstrations of the interdependence of practise and theory, I shall relate it to you. In 1886 Ehrlich observed that methylene blue and some of its congeners were the only colors which stained the living nerve tissue, and in order to determine whether this remarkable property was due to the peculiar constitution of methylene blue or to the presence of sulfur, he found it desirable to experiment with a substance analogous to methylene blue, but in which the sulfur was replaced by oxygen. He applied to Dr. Caro requesting him to assist him in his work by furnishing him

the material necessary for his experiments.

As a substance of this constitution was then unknown, it was made to order, and in the course of this research the valuable class of rhodamine colors was discovered. Thus experiments with nerve tissues gave birth to the manufacture of coal tar colors of the greatest importance in the textile industries.

The dyestuffs methylene blue and some others are also of great value as internal remedies, and the former is strongly recommended by one of the greatest American authorities for the relief of pain in that horrible disease—cancer.

The medicinal properties of the coal tar colors lead us to that branch of the industry which is next in importance, namely, the coal tar remedies. Incidentally, it may be mentioned here that before these so-called synthetics were introduced, Kolbe had succeeded in 1874 in artificially preparing from coal tar salicylic acid, which up to that time was exclusively a product of nature. Salicylic acid has been, and is still to-day, used extensively as a remedy against rheumatism.

The industry of synthetic drugs owed its origin also to the efforts of chemists to produce quinine artificially. Experiments had shown that by decomposing quinine a substance called quinolin was formed, and the latter was likewise found to exist in coal tar. It was then assumed that quinine must in some way be derived from quinolin, and that perhaps other derivatives of quinolin might possess properties similar to quinine. This trend of thought led to the discovery of the quinolin derivatives, thallin and kairin, which, however, were soon discarded on account of their drastic action and to-day possess only historical interest.

In 1883 Knorr, starting from erroneous deductions concerning the constitution of quinine, and also misinterpreting the constitution of some of the products obtained in his research, inspired the pharmacological study of a substance afterwards called antipyrin. This product proved to be of the greatest value in medicine and was the first successful synthetic coal tar remedy in the market.

Shortly after the introduction of antipyrin a fortunate accident gave this modern art an unexpected stimulus, diverting the investigation from quinine and uncovering an entirely new field. Kahn and Hepp, two physicians connected with the Strassburg University, were on terms of friendship with a chemist of the Hoechst Works, where Knorr's antipyrin was being manufactured, and requested him, in 1886, to send them some chemically pure naphthalene, which they desired to use internally in the case of a patient suffering with some skin disease. They received the substance, and on administering it found that while it failed to exhibit the expected effect, it promptly reduced the existing fever. When the supply of naphthalene was almost exhausted, they wrote for a further quantity; but, to their great astonishment, the second supply, unlike the first, did not manifest any antipyretic action, and on comparing the two, they soon discovered that a mistake had occurred somewhere. An investigation showed that when the first request was received the laboratory boy was directed by the chemist to fill a bottle with naphthalene and mail it to his friends, but through an error some acetanilid was sent instead, while the second time the chemist himself filled the bottle correctly. Thus through an accident acetanilid was introduced into medicine, a remedy which to-day is used by the ton as an antipyretic and antineuralgic, and through the irony of fate the most powerful competitor of antipyrin was discovered as the result of a mistake made in the very factory which

was realizing enormous profits from the production of antipyrin.

When it was recognized that the acetylization of an amine produced a body of so much value, this process was tried with many amines and other suitable substances, and in consequence such important remedies as phenacetin were obtained, while by substituting lactic acid for acetic acid, lactophenin was prepared, and by means of amidoacetic acid, a drug named phenocoll.

After chemical researches had shown that the active principles of vegetable purgatives, such as rhubarb, senna, cascara-sagrada and aloes were anthraquinone derivatives, synthetic preparations of this class, which therefore are closely related to the alizarine colors, are now brought into the market. These new remedies have the advantage over the crude drugs of greater uniformity of action and exactness in the dosage.

The active principle of the suprarenal gland first isolated and investigated by an American scientist, a substance of surprisingly simple chemical constitution, has been obtained from coal tar, and it is said that this synthetic product is now marketed, and from experiments carried out in Europe and in the large works of Parke, Davis & Company in this country, we may expect that derivatives of this body will soon appear which will be even superior in their pharmacological effect to nature's product.

About the time that the first synthetics were brought out, a very curious chemical was discovered also by American ingenuity, which is to-day not only used for medicinal, but also on a large scale for industrial purposes. I refer to saccharine, a substance derived from coal tar, which is 550 times sweeter than sugar, and is the first representative of the class of artificial sweeteners. It may be of interest to relate an instance showing how purely theoretical investigations may lead to the building up of an important industry.

Dr. Fahlberg, working under the direction of Professor Ira Remsen at Johns Hopkins, was experimenting with coal tar derivatives from a purely scientific point of view. Before leaving the laboratory one evening, he thoroughly washed his hands, and was under the impression that he had taken every pains in doing so. He was, therefore, greatly surprised on finding that, during his meal, when carrying bread to his mouth, the hands had a sweet taste. He suspected that his landlady had unintentionally sweetened the bread and called her to account. They had a little discussion, from which she emerged the victor. It was not the bread that tasted sweet, but his hands, and, much to his surprise, he noted that not only his hands but also his arms had a sweet taste. The only explanation that he could think of was that, notwithstanding the thorough washing, he had brought some chemical along from the laboratory. Rushing back to it and carefully investigating the taste of all the goblets, glasses and dishes standing on the working table, he finally came across one whose contents seemed to possess a remarkably sweet taste. *Thus was made this important discovery.* What remained to be done was accomplished by later researches with this substance. He found very soon that saccharine, as the product was named, when diluted assumed the taste of cane sugar. In watery solution, for instance, its taste was as pleasant as sugar water. The product seemed to be worthy of utilization, provided its other properties were not objectionable.

Physiological experiments were now made on animals, and then on human beings, which showed that it was eliminated undecomposed, and that therefore the human organism behaved indifferently towards the substance. Furthermore, as

no perceptible disturbance of the general condition could be observed, it could be assumed that saccharine had no deleterious influence whatsoever upon the general health.

With the introduction of this artificial sweetener, a new industrial field was opened up, and the significance of this discovery can be easily imagined when you consider that four pounds of this material are equivalent in sweetening power to one ton of cane or beet sugar. It was soon manufactured on such a large scale that it seriously threatened the beet sugar industry of the continent, and as the latter was of much more economic importance than the production of saccharine, laws were enacted which prohibited the industrial use of the sweetener as a substitute for sugar, permitting its employment solely for medical purposes, the German government even going so far as to make a sort of state monopoly of the manufacture of this material.

Still another industry has undergone vast changes through Perkin's discoveries and since the beginning of the coal tar epoch—the manufacture of artificial perfumes. Nitrobenzol, under the name of mirbaneoil, was in the market as artificial oil of bitter almonds even before Perkin's mauve. It was used to some extent for scenting soaps. To-day a great variety of synthetic perfumes are manufactured. The odor of musk is successfully imitated by a nitrated hydrocarbon derived from coal tar; the odor of violets, of roses, of jasmine, of heliotrope, is reproduced artificially by synthetic substances, and the favorite American flavor, the oil of wintergreen, is manufactured from coal tar. And in this art also the hand of the master is seen in what is called the Perkin Reaction, through which he first succeeded in preparing from coal tar, coumarin and cinnamic acid.

The singular correlation of all these coal tar products appears from the fact that the odoriferous principle of jasmine is derived from the same mother substance which furnishes synthetic indigo, namely, anthranilic acid.

Between the products giving the sweet odors of flowers and the death dealing explosives there would seem to be a broad chasm, but not for the synthetic coal tar chemist. In fact the same nitrobenzol which was the first artificial perfume is used to-day with nitroglycerin as a safety explosive. The latter has the disadvantage of congealing when exposed to the cold and then becoming highly dangerous; the admixture of nitrobenzol keeps it liquid at very much lower temperatures. Trinitrobenzol and its homologues, especially trinitrocarbolic acid, or picric acid, are to-day employed as safety explosives by the miner and in proper mixtures as smokeless powder by the armies of the civilized world.

While coal tar preparations thus destroy life, so they likewise sustain life, for by the use of salicylic and benzoic acids, both products of nature but now derived chiefly from this source, it becomes possible to preserve the canned foods so indispensable to the soldier, sailor and explorer.

In conclusion, mention must be made of the use of coal tar colors and preparations in the reproductive arts, in which they play a most important part. Inks for printing and writing are made with coal tar colors and in photography coal tar preparations are now used almost exclusively for the development of the latent pictures on films, plates and paper. By the addition of certain coal tar colors to the photographic emulsion the latter becomes extremely sensitive to light and can then be used for instantaneous exposures, as in snapshots, and thus kodak fiends are the direct offshoots of the coal-tar industry.

By means of coal tar colors even one of the greatest of all problems—photography in natural colors—has been realized.

Curious to relate, with all these successes to its credit, the problem which has occupied the attention of master minds now for almost a century, and which was the incentive of Perkin's research, so fruitful in other fields—the artificial production of quinine—remains unsolved up to the present day.

While thus new arts were constantly developed, the chemical industries, existing at the time of Perkin's discovery, were also eminently benefited. The production of aniline required at once large quantities of sulfuric and nitric acids for the nitration of benzol, and the demand of the new industry for highly concentrated sulfuric acid gave to the world the contact process in which the sulfurous acid gas, formed, for example, in roasting zinc and iron pyrites, which heretofore was allowed to escape and then vitiated the atmosphere and destroyed vegetation, is converted into sulfuric acid by the oxygen of the air. The manufacture of alizarin consumed enormous quantities of caustic soda. Bromine and iodine became staple articles of commerce. The electrolysis of salt solution was economically perfected, and together with the contact process and the liquefaction of chlorine is employed on an immense scale for the synthesis of indigo. The experience gained in electric methods is being applied to the problem of utilizing the nitrogen of the air, and to judge from past successes, it will not be many years before the Badische Anilin and Soda Fabrik, in whose laboratories experiments in this direction are being conducted, will bring to the market nitrates, nitrites and nitric acid made from atmospheric nitrogen, instead of Chile saltpeter, the supply of which is calculated to last no longer than about twenty years, and as Chile saltpeter is indispensable in agriculture, especially in the raising of cereals, its artificial production in the manner indicated will remove the anxiety expressed by writers on economics concerning the difficulties of feeding an ever-increasing population owing to the gradual exhaustion of the soil.

The distillation of coal tar itself was changed in every respect to comply with the new developments. All its by-products are utilized, and one of them, sulfate of ammonia, is produced so economically that it is commonly employed as a fertilizer.

In the cooking processes, of so great importance in the manufacture of iron and steel, the gaseous products are not allowed to go to waste any more, but are recovered and utilized to furnish benzol, etc., in addition to illuminating gas—in fact, the United Coke and Gas Company operates some of its plants in such a manner that the gases are the principal products and coke only a by-product.

In the treatment of these gases, cyanide of potassium is obtained at such low cost that it is used for extracting low class gold ores which hitherto were useless. Hence this substance plays an important part in the monetary system, as its cheap production has disposed of the fear that there would not be enough of the precious metal to maintain the gold standard of the civilized nations.

The chemistry of benzol gave us our modern theories, especially that of Kékulé, which in its application led to marvelous prophesies of experimental results and is recognized to be one of the most remarkable achievements of the human mind.

The coal-tar industry gave us our modern chemical institutes, the wonderful equipments of which were first utilized in the laboratories of the factories, and above all it gave us the intimate cooperation of

technics and science which is in fact at the root of all this magnificent success.

In closing permit me to say that it is unique in the history of civilization that the honor and credit for the creation of this enormous material and spiritual wealth is unanimously and ungrudgingly accorded to Sir William Henry Perkin. It is unique that the creator of this vast industry has been so fortunate as to witness its wonderful development during fifty years. It is unique that when no longer engaged in the industrial part of our science, he undertook a series of theoretical investigations of the utmost difficulty, which only the most gifted have the courage to attempt, and that in this branch, too, he has conquered a position as lofty as his fame as a manufacturing chemist.

The world can not spare such an extraordinary man. May he live for many years to come and may his life be replete with health and happiness.

Hugo Schweitzer.

ADDRESS OF SIR WILLIAM HENRY PERKIN.[1]

It is now twenty-two years since I visited the United States. I was attending the first British Association meeting that was held at Montreal and then extended my visit to Yellowstone Park, returning by Chicago, Washington, Baltimore, Philadelphia, New York and Boston back to Montreal. At that time I certainly never anticipated that in twenty-two years' time I should be in this city at a jubilee celebration of the discovery of mauve and the foundation of the coal tar color industry. It was, indeed, quite unexpected and a matter of surprise to me when I heard that an international celebration was about to be inaugurated in my own country, which took place in July last. This included nations on both sides of the world, as you sent Dr. Baekeland as a delegate to represent America, but it was a still greater surprise to find that you were not satisfied to merely join the English jubilee, but had determined on having a jubilee celebration of your own in this city, which I should be invited to attend. I can only say how greatly honored I feel and how gratified I am at being present here to-night at this banquet, and meeting so many fellow workers in the field of science, and other friends. From the very cordial and friendly reception you have given me, I do not feel at all strange in coming amongst you, especially as I realize how closely we are related to each other by race and language, which naturally engenders a strong feeling of sympathy between us, a feeling which has been so heartily manifested this evening by the warm welcome given by the City of New York, through the Hon. Patrick McGowan, president of the Board of Aldermen, and also in a practical manner by the presentations given by Dr. Nichols, Mr. Kuttroff and Dr. Hillebrand.

The foundation of a medal bearing my name to be annually awarded to an American chemist, I feel to be a great honor, especially as I have all my life insisted on the importance of research work, and if this medal should help to encourage and stimulate some chemists to increased activity in this direction, this jubilee celebration will have accomplished a valuable result. And when we consider the advantages you fortunately have in this country by the existence of a very large research fund, we can not but believe that this will be the case. I thank you very sincerely for presenting me with this beautiful medal, the first that has been struck, which I value very highly.

With respect to the beautiful personal token you have presented to me, I scarcely know how to express myself. I am sure it will always be greatly valued not only by

[1] Given at the banquet tendered to him at Delmonico's, New York City, October 6, 1906.

myself but by Lady Perkin and my family. It has the merit of not only being beautiful but also very useful, and it is a very suitable gift for a total abstainer who is very partial to a cup of tea. Whenever we use it it will remind us of the warm-hearted hospitality which has been shown us in America.

I appreciate very much the honor the American Chemical Society has done in electing me one of its honorary fellows and presenting me with its certificate of membership this evening. I am very pleased, indeed, to have my name associated with this important society, the value of which I gauge from my knowledge of the help the London Chemical Society has been to me, and of which I have this year also completed my jubilee of membership.

I very heartily thank Dr. Nichols, Mr. Kuttroff and Dr. Hillebrand for all their kind and generous remarks in reference to myself when presenting me with these gifts.

That this jubilee should also have another important object in view, namely, the foundation of a reference and circulating library for science, is also a great satisfaction to me, as it may be the means of not only affording useful information to scientific workers, but also of stimulating research.

I am very glad that Professor Chandler is the president to-night. I have known him for a long time, and we must all admire the indomitable perseverance with which he has worked for the cause of chemistry in this city, for now over forty years without flagging. His position as chairman on this occasion is particularly fitting, because of the varied ways in which he has been connected with the coal tar industry, and his acquaintance with the great works in which the colors are made, and I also know the very hearty and active part he has taken in connection with this celebration. I thank him also most sincerely for the kind things he has said in reference to myself.

We have all listened with interest to the remarks of Dr. Schweitzer, who is not only practically connected with the coal tar coloring matters, but has also done good scientific work in connection with them. I thank him also for all the kind references he has made to me. And I take this opportunity of thanking him and all other members of the committee for the pains they have taken to make my visit to this country so extremely pleasant and enjoyable, not only to myself, but also to Lady Perkin and my daughters. It is a landmark in our lives to which we shall always look back with pleasure.

I have no doubt that some of you will have read the particulars of the London celebration and what I said on that occasion, and this makes it difficult for me to address you, and if I repeat much of what I said then, I must claim your indulgence, because one can not but state the things which have occurred in one's lifetime; they can not be varied. As I expect that many of you, however, may not be so well acquainted with the history of the coal tar color industry and the mauve dye which was its starting-point, as people are in the old country, I thought that you might like me to give a brief account of it, especially of its early days, but even to do this is difficult in the time at my disposal, and, moreover, as I shall have to speak about myself, it would have been more agreeable to me if some one else could tell the tale. To begin, it may perhaps first of all interest you to know something of my early days and how I became a chemist.

As long as I can remember, the kind of pursuit I should follow during my life was a subject that occupied my thoughts very much. My father being a builder, the first idea was that I should follow in his footsteps, and I used to watch the carpenters

at work and also tried my hand at carpentering myself. Other things I noticed led me to take an interest in mechanics and engineering, and I used to pore over an old book called the 'Artisan,' which referred to these subjects and also described some of the steam engines then in use, and I tried to make an engine myself and got as far as making the patterns for casting, but I was unable to go any further for want of appliances. I had always been fond of drawing and sometimes copied plans for my father, whose ambition was that I might be an architect. This led me on to painting and made me think I should like to be an artist, and I worked away at oil painting for some time. All these subjects I pursued earnestly and not as amusements, and the information I obtained, though very elementary, was of much value to me afterwards. But when I was between twelve and thirteen years of age a young friend showed me some chemical experiments, and the wonderful power of substances to crystallize in definite forms, and the latter, especially, struck me very much, with the result that I saw there was in chemistry something far beyond the other pursuits with which I had previously been occupied. The possibility also of making new discoveries impressed me very much. My choice was fixed, and I determined if possible to become a chemist, and I immediately commenced to accumulate bottles of chemicals and make experiments. About this time I changed my school and was sent to the City of London School, and to my delight found that lectures on chemistry and natural philosophy were given there twice a week during the dinner interval. These I attended, and not long afterwards the lecturer, seeing the great interest I took in science, made me one of his lecture assistants, my duties being to prepare the experiments, arrange the table and assist at the lectures. This was a great lift to me, and I daily used most of the interval for dinner and not infrequently all, but the abstinence from food this caused did me no harm, as nearly all of us eat far too much. This interval was the only time I had for fitting up apparatus and preparing for these lectures. The lecturer was Mr. Thomas Hall, B.A., one of the class masters, and he was very kind to me and helped me in every way. My father was disappointed at my choice, and the outlook for chemists was, indeed, very poor in those days, and naturally that was a matter that weighed with my father, but Mr. Hall had several interviews with him and eventually I was allowed to follow my bent, and at the age of fifteen I left school and entered the Royal College of Chemistry in London, where Dr. Hofmann was professor.

Under Dr. Hofmann's able instruction I soon got through the ordinary course of qualitative and quantitative analysis and also gas analysis; this I looked upon only as a preliminary part of my chemical acquirements and not, as many used to and some still do, as a full equipment. Research was my ambition and under the professor's guidance this was entered upon and the first investigation completed when I was seventeen. I then became honorary assistant in Dr. Hofmann's research laboratory and helped to carry on his scientific enquiries, and in this way I quickly acquired a considerable insight into the chemical science of that day, as well as experimental experience. My time being much occupied with the professor's work, I had little opportunity of carrying on research on my own account. I, therefore, fitted up part of a room in my father's house and made a rough laboratory, a very different place from the laboratories of the present day. Spirit lamps and charcoal, for combustion, had to be used as sources of heat, as there was no gas. In this labora-

tory work was carried on in the evenings and vacation time. In those days one of the problems was the artificial production of vegetable and animal products, and amongst other subjects I was ambitious enough to try and produce quinine artificially, of course from purely scientific motives, but, as is frequently the case, the research took an unexpected turn; no quinine was formed, but only a dirty reddish-brown precipitate. Unpromising though this result was, I was interested in it and thought it more desirable to experiment with an analogous but more simple material than I had previously used. *Aniline* was, therefore, taken, but in this case I obtained a black and more unpromising product, but on submitting this to investigation found it contained, besides other things, a beautiful purple coloring matter which was found to be capable of dyeing silk and other materials, and it was in fact the product we now know as the 'mauve dye.' This discovery was made in the Easter vacation of 1856. I showed this dye to some of my chemical friends, who thought it might be valuable, but its evident costliness and the difficulties of preparing aniline for its production on a large scale made the probability of its proving of practical value very doubtful. At this time aniline was a very rare product, only found in a few research laboratories, and could not be purchased. Having obtained an introduction to Messrs. Pullar of Perth, the well-known dyers, some pieces of dyed silk were sent to them, and they reported: "*If* your discovery does not make the goods too expensive it is decidedly the most valuable that has come out for a long time." This report was very satisfactory except the *'if'* it commenced with. During the summer vacation, and with the help of my brother, Mr. T. D. Perkin, larger experiments were made and consequently larger quantities of coloring matter obtained, and it was then decided to patent the process, but a difficulty arose. I was but eighteen years of age, and it was questionable whether a patent could be granted to any one under twenty-one (a minor). Counsel's opinion had, therefore, to be obtained, and this was to the effect that, a patent being a gift from the crown, the matter of age did not affect the grant. Further experiments were then made on dyeing and calico printing, and although the colors were admired, that terrible *if* respecting the cost was always brought forward, besides other questions. Nevertheless, I became persuaded in my own mind of the importance of the dye, and as a consequence I gave up my position as assistant to Dr. Hofmann that I might follow up the subject, but at this he was annoyed, probably thinking I was taking a false step. I was also much afraid that by entering into this technical pursuit my research work might be prevented, but I determined that so far as in me lay this should not be the case.

But the difficulty in starting this new industry was that no one was willing to come forward with the requisite capital, because they were not ready to risk it on such a new and untried product as this dye. My father, however, although he had been disappointed at my becoming a chemist instead of an architect, nevertheless, had so much confidence in my judgment that he very nobly risked most of the capital he had accumulated by a life of great industry by building and starting works for the production of this mauve dye. Had it not been for this generosity on his part, for which I have always felt very grateful, probably I should not have been able to start this industry. My father and brother joined me in this undertaking, and I feel that my success was largely due to their collaboration. Time would fail me to enter into all the difficulties that beset the

establishment of this unique industry, not only in having to invent a suitable plant, but also to obtain even the raw material, which was not then made of a definite quality. The processes were quite different in character from those in existing chemical industries. The coloring matter also when made was quite different from ordinary dyes in its properties, and methods for its application as a dye had to be discovered, and this consumed much time. In fact, it was all pioneering work. Nevertheless, the mauve was supplied for silk dyeing as early as December, 1857.

I have mentioned these particulars because the production of this new color and the practical proof of the possibility of manufacturing it commercially was the foundation of the coal tar color industry. When the mauve was seen to be a success, of course every one commenced experimenting with aniline, and three years after its discovery magenta was discovered by M. Verguin in France. None of the difficulties I have mentioned were encountered in the manufacture of this dye; the way was clear and all the processes for the application of the mauve were equally suitable for the magenta, and, moreover, none of the first prejudices in reference to such an innovation as the mauve any longer existed.

Other coloring matters were then discovered by myself and in France by Messrs. Girard and Delaire and then by Dr. Hofmann in England, many of which were derivatives of magenta. These were produced not only in France but largely in England by Messrs. Simpson, Maule and Nicholson; they were also made to some extent in Germany and Switzerland, and very soon dyes of all the colors of the rainbow were obtained from commercial aniline, and the industry made very rapid progress.

In 1868 Graebe and Liebermann commenced an investigation on alizarine, the natural coloring matter of the madder-root, from a purely scientific point of view; this led to the remarkable discovery that this coloring matter is related to a coal-tar product called anthracene, and they also succeeded in producing it from this product. This was the first natural coloring matter which had been produced artificially. Their process, however, was not suitable for the production of this coloring matter technically. Having in my research work studied anthracene and some of its products, I endeavored to find a practical process for the formation of alizarine, and after a time succeeded in finding two suitable methods for its production on the large scale. Caro, Graebe and Liebermann quite independently also discovered one of them. I and my brother then took up its production at our works (my father having died previously), but many difficulties were encountered, one being that of obtaining anthracene, which was not then a commercial product, but after visiting most of the tar works in England and instructing the tar distillers and agreeing to take what they could make, a supply was soon obtained in all different states of purity, which quickly increased. In the meantime the difficulties of the manufacture were overcome and we were soon able to commence supplying alizarine to the turkey-red dyers. Our output rapidly increased, and this artificial coloring matter has now become one of the most important of the coal tar colors and has superseded the natural dye, so that the cultivation of the madder root has practically ceased. In the year 1873 the demand for alizarine had so increased that we felt that it would be necessary to enlarge our works two or three times to meet the demand. My brother and I, however, did not care to undertake this great responsibility; we, therefore, sold our works, hoping our successors would follow up the matter.

This ended my connection with the color

industry from a manufacturing point of view. After this I occupied myself with scientific research, some of which was connected with coal-tar coloring matter, but mostly with other subjects. Some of these are still occupying my attention. But I must not enter into details, as time would fail me.

One of the most remarkable developments of the industry has been the artificial production of indigo, and, curiously, the first process for its manufacture, discovered by Professor v. Baeyer, was dependent for its success on the method of producing cinnamic acid, discovered in my purely scientific investigations, and this dye is now manufactured so cheaply that the cultivation of the indigo plant has been discontinued in many parts of India.

As I mentioned, when I started this industry I was determined not to give up scientific research, and so long as I had to do with it the part I took in its development resulted from the union of industry and scientific research. This has been followed up by others, especially in Germany, and owing to the work of an army of chemists, many of them men of great eminence and most of them engaged in the works and their laboratories, this wonderful development, unequaled in the history of industry, has taken place. This industry has also had a marvelous influence on the development of science itself. Its wonderful growth has also, as a matter of course, created not only directly but indirectly an immense amount of employment for men of all classes, especially the working classes, which can not be gauged, and although America has not become a manufacturing center for the production of these dyes, no doubt many thousands of American workers are engaged in the applications. That this industry which I was permitted to found should have led to this result is a source of pleasure to me, because the final result of our work should be the benefit of mankind.

You have been so good as to honor me by having this jubilee in remembrance of the part I have taken in connection with this coal tar color industry, and whilst I am thankful that I had to do with its foundation and early development, yet I feel that the part I have taken is indeed small when compared with the labors of the army of scientific men and others, both inside and outside the color works, who have advanced it to its present condition. At the same time it is very gratifying to me to receive all the generous and kindly expression of feeling you are manifesting, and I thank you very heartily. But what have I that I have not received? It is not, therefore, for me to boast (and I also feel that I have but imperfectly used my opportunities). I, therefore, can only say in reference to the success which has attended my efforts, Not unto me, O Lord, not unto me, but unto thy great name be all the praise.

REFORM IN MATHEMATICAL INSTRUCTION.

THE principal mathematical reforms recommended by the commission appointed by the Gesellschaft Deutscher Naturforscher und Aerzte is that more emphasis should be laid on the development of the concepts of *function* and *space*.[1] As the commission realized that such fundamental changes are not likely to be accomplished by a mere publication of the results of its deliberations, it appointed two of its members—Professor Klein, of Göttingen, and Professor Chun, of Leipzig—to try to interest secondary teachers in the subject, and, if possible, to bring them to discuss it very freely.

[1] 'Bericht der Unterrichtskommission der Gesellschaft Deutscher Naturforscher und Arzte über ihre bisherige Tätigkeit,' Leipzig, F. C. Vogel, 1905.

The chief aim in this reform is to bring the mathematical instruction in closer touch with applications. Related variables present themselves very frequently in the sciences, and the training in algebra should prepare the student to deal with these concepts in an intelligent manner. More stress should be laid on the study of expressions and less on the analytic transformations and the solution of equations. Graphic representations are especially helpful in the study of the various values of algebraic expressions, and hence these should occupy a more prominent place in algebra. Fortunately, these changes are being effected not only in Germany and France, but, perhaps, in a more rapid manner in England and in America.

The instruction in elementary geometry is at present undergoing the most radical changes, especially in England, which was the last great stronghold of Euclid. The fact that Euclid's 'Elements' remained a standard elementary text-book on geometry for two thousand years reflects less credit on Euclid than disgrace on those who followed him slavishly. During the last few years England has abolished Euclid servitude and her freedom is clearly exhibited in the recent text-books. The 'Manual of Geometry,' by the well-known author, W. D. Eggar, is, perhaps, a somewhat extreme case. In this book there is a chapter describing the vernier, spherometer, callipers and the micrometer screw gauge. It also treats briefly of the mensuration of the simpler geometrical solids, trigonometric ratios, and four-place logarithms.

In France the 'Nouveaux éléments de géométrie' by C. Meray has, perhaps, been the most effective in producing a decided advance. In this work the plane and the solid geometry are not separated, the concepts parallelism and perpendicularity are established by means of translations and rotations, and the theorems relating to the congruence of triangles are developed later than is customary in the classical works. At a recent meeting of the French Association for the Advancement of Science a resolution was passed requesting the minister of public instruction to assist in securing a more general adoption of these methods in the text-books.

While we may not be able to foretell what the elementary geometry of the next decade will be, yet it seems probable that philosophy will largely give way to observation, the abstract to the concrete, the rigor which appeals to the scholar to the elementary methods leading to a clearer understanding of our physical surroundings. In view of the fact that England was the last one of the great nations to abandon Euclid, it seems likely that she will soon produce the best text-books in elementary geometry, for she is in a position to profit by the experience of the nations which made the transition at an earlier period.

There are two subjects whose elements should constitute a part of a regular course in elementary geometry, viz., analytic geometry and vector analysis. These open up such wide fields and are of such an elementary character that the average student would enjoy their study much more than the proof that two right angles are equal or that one side of a triangle is less than the sum of the other two. Moreover, both vector analysis and analytic geometry furnish simpler and more direct proofs of many theorems than the ordinary methods of elementary geometry and it seems poor policy to teach the poorer methods first.

The increasing use of graphic methods both in algebra and in the other sciences calls for a much earlier study of the elements of analytic geometry, and the enormous progress of physics calls for an early

acquaintance with such a strong tool as vector analysis. Moreover, a vector has so many physical applications that the line representing it becomes full of meaning to the student, and geometric constructions thus admit of interpretations which escape the notice of the student whose geometrical training has proceeded along the old lines.

The plea for an early introduction of the methods of analytic geometry has historical support since the 'Tractatus de latitudinibus formarum' of Oresme was popular during the period of the early development of European universities when very little of Euclid's 'Elements' were taught and the mental advancement of the students was low. The graphic representation of a function upon which so much stress has been laid in recent years was relatively farther advanced in these early days than it is at the present time. The thought of direct usefulness is again assuming a more dominating influence in early mathematical instruction. We are laying more stress upon the student's ability to use a theorem intelligently than upon his giving a faultless demonstration. In fact, a prominent Harvard professor is said to have told his students that the demonstration of a theorem is no evidence that it is understood, but the intelligent use of the theorem constitutes such evidence.

A fundamental aim in early education is to give the student a clear comprehension of the world in which he lives and to furnish him with the necessary knowledge to make a wise use of his faculties. In view of the fact that the sciences and their applications are continually playing a more prominent rôle in the civilized world and that international relations are becoming more and more important, it becomes necessary to readjust the machinery of education from time to time. Many of the necessary changes should be regarded as steps towards a proper readjustment rather than as fundamental progress. In view of the great conservatism in mathematics the readjustment along this line is apt to be slow and to require unusual perseverance.

When such strong men as Klein, of Germany, Forsyth and Sir Oliver Lodge, of England, Moore and Fiske, of America, take active part in reform movements they are certain to be effective. The discussions in Germany in recent years have been so active that Gutzmer describes them as stormy at times.[2] In France the discussions have received less attention, but there has been a decided movement towards graphic methods and especially towards the early use of the differential and integral calculus. In England Professor John Perry, of the Royal College of Science in London, has probably done the most radical and effective work, so that the reform movement is sometimes known as the 'Perry movement.'

While these tendencies in elementary mathematics have some influence on mathematical instruction in the universities, yet they do not affect this work nearly so much as the elective system in secondary education. In view of the diversity of the courses pursued by students before entering the universities, the departments where the work has to proceed step by step, as in mathematics, are compelled either to make provision for more elementary courses or to exclude a large number of students. This difficulty exists not only in our institutions but also abroad, and Klein, for instance, urges that the universities should meet the difficulty by offering a greater variety of courses. He discourages the efforts on the part of friends of the real gymnasium who have tried to abolish some elementary courses in languages at the universities with a view to securing a more general

[2] Jahresbericht der Deutschen Mathematiker Vereinigung, Vol. 13, p. 517.

recognition of the equality of their courses to those of the older gymnasium.

A fundamental tendency in the early university instruction is towards a closer coordination with applications. In a less marked degree the coordination of the various mathematical subjects has been considered. The latter seems wise, as reforms should begin at home. Before considering the closer union of mathematics and physics, for instance, it might be well to consider whether the water-tight compartments of the various mathematical subjects are not doing more mischief than those between the various departments. While mathematics should be taught with a view to helpfulness to other departments, yet its first duty is to help itself and to secure its own harmonious development. A starveling can not render strong service to others.

G. A. Miller.

University of Illinois.

SCIENTIFIC BOOKS.

California Mammals. By Frank Stephens. Illustrated by W. J. Fenn from studies in the field. Published by the West Coast Publishing Co., San Diego, California, 1906. 8vo, pp. 352, frontispiece, 6 half-tone plates, 40 illustrations in the text, and a faunal map.

'California Mammals,' by Mr. Stephens, is noteworthy as being the first recent local 'handbook' of the mammals of any part of North America, and fortunately sets a fairly good standard for the many similar much-needed local manuals of our mammals that we hope may speedily follow. The scope of the work is "California and that part of the Pacific Ocean properly belonging to California. All the mammals described are known to have been found within the state or within sight of its shores." The number of species and subspecies treated is 276—a surprisingly large number, yet readily explained by the great latitudinal extent of the state, and its extremely diversified character, ranging from the subtropical desert areas of the southeastern part to the subarctic snow-covered summits of the Sierra Nevada.

Although diagnoses of the higher groups, from class to genus, are given, the work is written as far as practicable in non-technical phraseology, but for the convenience of such readers as may not be familiar with some of the terms necessarily employed, a three-page glossary is supplied. Mr. Stephens is well equipped for his work, having had a long field experience as a natural history collector in California, and is thus able to give the ranges of the species and subspecies, particularly of the southern two-thirds of the state, largely from his own personal knowledge. The descriptions of the forms are brief, but for the most part give all there is to say. These are followed by a statement of the type locality and range, and by a few lines to several pages of original biographical matter, according to the circumstances of the case. There is no synonymy, nor any bibliographical references, but the life histories are an important contribution. The illustrations are not numerous, and relate wholly to external features. Good figures of skulls of a considerable number of genera would have been a valuable addition; an extended bibliography was obviously beyond the scope of the work, but a list of titles of the principal papers relating to California mammals would have been useful. The book had to have its limitations, and for a work so well done as is this, and containing so much that is convenient and valuable, it is perhaps hardly fair to make suggestions that the author, perhaps, considered and found impracticable of execution. There is only one thing to say in the matter of serious criticism, and that is that the work is worthy of better typographical execution. The text, as to matter and style, is excellent, but the proofreading is unfortunately defective.

The work is intended for 'beginners' and not for experts, yet it is doubtless equally welcome to both, and for the first class it has been put together with excellent judgment. For many of the subspecies, especially in certain groups, it is almost impossible to give

any characters by which they can be distinguished from their next of kin. The differences are merely comparative and often intangible, and the author kindly warns his readers that they can not hope to satisfactorily discriminate between them; and that when certain groups 'are critically studied as a whole,' as in the case of *Thomomys*, a considerable number of them 'will probably be dropped.' Under coyotes, of which three *species* are credited to California, he says: "Little harm would be done if all the California coyotes were grouped together under the name [*Canis*] *ochropus*. * * * Those not experts will find it difficult to determine the species of coyotes."

Following the main text is a chapter on 'Life Areas in California' (pp. 283–291), illustrated with a map, on which are indicated the seventeen faunal divisions the author has found it desirable to recognize. This is followed by a 'List of California Mammals and their Faunal Distribution,' which is noted by means of references to the map. A glossary and a very full index (40 pages) close the volume. J. A. ALLEN.

Physiology of the Nervous System. By J. P. MORAT, of the University of Lyons. Authorized English edition, translated and edited by H. W. SYERS, M.A., M.D. (Cantab.), Physician to the Great Northern Central Hospital. With 263 illustrations (66 in colors). Chicago, W. T. Keener & Co. 1906. Pp. xxviii + 680.

This work, a portion of the 'Treatise on Physiology' by Professors Morat and Doyon, is a full and systematic exposition of the physiology of the nervous system. The subject has been treated with great clearness and conciseness. The elementary nervous functions, including the anatomy and functions of the neuron in general, the methods of using electricity in the study of nerve actions and the effects of nerve poisons, are discussed in the first part. The individuality of the neuron is brought out as the essential point in the theory of the nervous element without entering into a technical discussion on the *continuity* or the *contiguity* of the articulated prolongations of these neurons. With reference to the question of nervous amœbism, as with other mooted points which at the present time only lead to fruitless discussion, the author takes a neutral stand. The laws of Waller, in modified form, are described in a clear manner. The views of Bethe, opposed to the Wallerian idea of the regeneration of the peripheral stump of the severed nerve, are not discussed, perhaps, to the advantage of the lucid presentation of the general laws of nerve degeneration. Death by electricity is discussed in the light of recent experiments on animals and of accidents arising in industrial applications of high-tension electrical currents.

The systematic functions, *i. e.*, the functions which originate in the associations and definite relationships which are established between the cellular functions, are discussed in the second part of this work. The relationships of sensation and motion are defined very concisely. In introducing this important chapter the author tersely says:

> Except for the infinitesimal part which each one of us plays therein a knowledge of the living world is based on anthropomorphic reasoning, and it is impossible to base it on any other reasoning. Hence it is necessary to exert great prudence in employing it.

This part contains sub-chapters on the metamerism of the spinal nerves; and their functions, and the fundamental determinations of the cranial nerves. The pneumogastric and trigeminal nerves are very thoroughly treated. The chorda tympani is regarded, together with the two superficial petrosal nerves, as the principal continuation of the nerve of Wrisberg (nervus intermedius). In the second chapter the reflexes, conscious, sub-conscious and unconscious, are classified and described extensively. The author avoids attempting to explain the mechanism of inhibition, but indicates by comparisons how this phenomenon belongs to the category of explicable facts of which the explanation itself is wanting.

The most noteworthy and interesting por-

tion of the work treats of the superior systematizations of the brain, comprising visual, auditory, tactile, olfactory and gustatory innervations. The chapter on language and ideation, together with the cerebral localizations of language and of the aphasias is particularly noteworthy. The phenomena of sleep, hypnotism, dissociations of personality, spiritualism and other topics belonging to the borderland between physiology and psychology are briefly defined in terms of physiological functions.

The work embodies the latest real advances in our knowledge of the nervous system without being burdened by superfluous references to trivial points of controversy. Each chapter is followed by a fairly extensive classified bibliography and the translator's work is practically faultless. The illustrations have been selected with care and are neither too few nor too many in number. The work will surely commend itself to both the physiologist and the practical neurologist.

Edw. Anthony Spitzka.

SCIENTIFIC JOURNALS AND ARTICLES.

The July number (volume 7, number 3) of the *Transactions of the American Mathematical Society* contains the following papers:

M. Mason: 'On the boundary value problems of linear ordinary differential equations of second order.'

M. W. Haskell: 'The resolution of any collineation into perspective reflections.'

L. E. Dickson: 'Linear algebras in which division is always uniquely possible.'

J. E. Wright: 'Correspondences and the theory of groups.'

E. Kasner: 'The trajectories of dynamics.'

R. Morris: 'On the automorphic functions of the group $(0, 3; l_1, l_2, l_3)$.'

R. G. D. Richardson: 'Improper multiple integrals.'

The opening (October) number of volume 13 of the *Bulletin of the American Mathematical Society* contains the following articles: 'Criteria for the Irreducibility of Functions in a Finite Field,' by L. E. Dickson; 'On the Theory of Equations in a Modular Field,' by L. E. Dickson; 'Notes on the Variation of the Definite Integral,' by N. J. Lennes; 'A Note on Transitive Groups,' by W. A. Manning; 'Differential Geometry of n Dimensional Space' (Review of Guichard's Systèmes triplement indéterminés et Systèmes triple-orthogonaux), by L. P. Eisenhart; Shorter Notices (Macfarlane's Bibliography of Quaternions and Allied Systems of Mathematics, by H. E. Hawkes; Echol's Elementary Text-book on the Differential and Integral Calculus, by M. W. Haskell; Cattell's American Men of Science, a Biographical Directory, by G. A. Miller); Notes; New Publications.

The American Naturalist for September contains the following articles: 'Histogenesis of the Retina,' by A. W. Weysse and W. S. Burgess; 'Notes on Marine Copepoda of Rhode Island,' by L. W. Williams; and 'Lichens of Mount Monadnock, New Hampshire,' R. H. Howe, Jr. The first paper is based on a study of the retina in the chick, is fully illustrated, and shows, among other things, that there is a large amount of individual variation in the rate of development of the retina as a whole, and also of its component parts. Mr. Williams, in his paper, records twenty-six species of copepods, three of which are described as new. Mr. Howe records no less than seventy-one species of lichens from Mt. Monadnock.

The Museums Journal of Great Britain for August contains an abstract of the Bristol meeting and a detailed history of the Bristol Museum and Art Gallery, by Ald. W. R. Barker. The next meeting of the association will be held at Dundee.

DISCUSSION AND CORRESPONDENCE.

CATS AS PLANT INVESTIGATORS.

It has taken half a lifetime for Americans to discover the delicious qualities of the pomelo, but it has taken the cats of Boston only six months to appreciate a new cat delicacy.

Professor Sargent, of the Arnold Arboretum, near Boston, imported from Central China a new vine, only a few plants of which were securable. As the species (*Actinidia pol*-

gama) was a rare one and had never before been introduced into this country, the plants were put in the greenhouse and carefully watched, but before they had made much growth the propagator, Mr. Dawson, observed that some animal was eating their tender shoots. There were no rats, as a cat was kept constantly about and Mr. Dawson was puzzled to discover what new kind of pest he had in his greenhouse. The thought that the damage was done by cats never occurred to him, until, after the plants were severely injured, when he discovered some cat hairs on the half-eaten branches, and, watching more closely, he caught the hothouse cat eating not only the small tender shoots, but the large woody twigs as well.

In the spring he set out over a hundred small vines in a cold frame but, to his surprise, after removing the protection which the sash afforded, the cats of the neighborhood destroyed the whole bed, eating the plants to the ground. They were not just nibbled, as are catnip or valerian, the only other plants known to be eaten by cats, they were completely destroyed—gobbled up—even to stalks as big as a lead pencil.

No place in the arboretum is now concealed enough to be safe from ravage, and the few two-year-old vines in it are completely protected by wire nettings. Every leaf or twig on these caged vines which is near enough the wires to be within reach of claws is scratched and torn to bits. In a few months time this entirely new plant from the interior of China has become the most relished vegetable which our American cats have ever tasted.

The plant has no odor that we can detect, neither has it any distinct taste. Did the cats scent it, or do cats, which are carnivorous animals, make a practise of tasting every new plant that comes within their ken? If they do, they certainly excel in investigative faculties the most civilized races of human beings. Then too, how did the news spread so that in a few months after its introduction all the cats of the neighborhood knew of it? Did the greenhouse cat communicate his discoveries to his friends, or did each cat make the test independently?

The whole story throws an interesting sidelight on cat instinct and intelligence and starts a score of questions. It is difficult to see how there can be here an instinct inherited through long generations of ancestry, for the plant has been unknown in Europe and America until a few years ago. It seems to show an alertness of cat intellect which is most remarkable and which is in sharp contrast with the reluctance of the average human being to taste new things.

DAVID FAIRCHILD,
Agricultural Explorer.
DEPARTMENT OF AGRICULTURE.

SPECIAL ARTICLES.

EVIDENCES OF SEVERAL GLACIAL AND INTERGLACIAL STAGES IN NORTHEASTERN NEW ENGLAND.[1]

WHILE conducting an investigation of the underground water resources of northeastern New England during the present field season, the writer has had occasion to visit many parts of northeastern Massachusetts, southeastern New Hampshire and southern Maine, and has incidentally noticed numerous cuts and exposures which throw light on the differentiation of drift in this long-neglected section of the country. There seems to be no longer any doubt that in northern New England, as elsewhere, there have been at least three distinct ice advances, separated by interglacial stages; and when more evidence has been obtained it will probably be possible to definitely correlate them with those of southern New England.

The writer hopes in the near future to publish a detailed account of his observations and conclusions. In the meantime a brief statement of the formations observed and their possible correlations with deposits in other sections may be of some interest.

1. *Pre-Pleistocene (Probably Tertiary) Clays.*—A deep boring made in Boston in 1905 penetrated over 100 feet of a fine light gray to white, very pure clay, underlying all glacial deposits. This clay appears to be of

[1] Published by permission of the director of the U. S. Geological Survey.

pre-Pleistocene age and later than the Carboniferous bed-rock of the region. Similar deposits are reported in borings elsewhere in Boston and were noted by Crosby in his report to the Committee on the Charles River Dam. Samples of this clay from the boring mentioned above were examined by the writer in the office and compared with specimens of various Quaternary, Tertiary and Cretaceous clays, and were found to be almost identical in appearance with much of the Cretaceous clay from borings on Long Island described by Veatch and called by him Raritan.

2. *Unconformity.*

3. *Very Ancient Till.*—This was observed at Lawrence and Haverhill, Massachusetts, at Norridgewock, Maine, and at a few other localities. It is composed of a larger percentage of local material than are the common tills of the region, is deeply oxidized, of a brighter yellow color, and very rotten. A few rounded pebbles of quartzite and similar durable rocks are contained in it, but no granitic or diabasic rocks could be found. These deposits are believed to correspond in age to the old tills described by Fuller in southeastern Massachusetts, with the Mannetto gravels described by Fuller and Veatch on Long Island and elsewhere and with the Kansan or the pre-Kansan till of the middle west.

4. *Unconformity.*

5. *Stratified Fossiliferous Clays.*—Small exposures of these beds underlie drumlins at Winthrop and Revere, Massachusetts, and the material derived from the clays, with its contained fossils, is incorporated in the drumlins of Boston Harbor. The deposits have been correlated by Fuller with the Gardiner clay of Long Island and Cape Cod. Local clays which are possibly of this age have been observed in Maine.

6. *A Thick Deposit of Till.*—This is the principal till sheet of New England, including hardpan deposits of sand, gravel, clay and bowlders, often of great thickness, covering all older formations. It includes the drumlins of Massachusetts and New Hampshire. Where it has not been eroded this till is yellowish from the effects of oxidation to a depth of five to fifteen feet. Until recently it has been considered of Wisconsin age, but Fuller has lately thrown it into the Illinoisan, correlating it with the Montauk of Long Island. The evidence collected this summer of a more recent till, confirms this correlation.

7. *A Great Thickness of Coarse Gravels.*—These are well developed in the Kennebec, Androscoggin and Penobscot valleys, and their relations are perhaps best exposed in the vicinity of Augusta, where they may be seen resting on (6) and overlain by (9) and (10). They were deeply eroded before the deposition of overlying deposits. These gravels may be equivalent to the gravels described by Fuller as overlying the Montauk till on Long Island, etc.

8. *Unconformity.*

9. *Fossiliferous, Stratified, Blue-Clay ("Leda-Clay" of Jackson, Hitchcock, Packard and others).*—This is an extensive deposit, rising from about twenty feet above tide in the vicinity of Boston, to over 200 feet in the Kennebec and Androscoggin valleys and found throughout the coast region and larger valleys between Boston and Eastport. This clay is well stratified, frequently fossiliferous, and is deeply oxidized. It is occasionally folded and contorted and often overlain by sand deposits and generally by till. Fossils, where found, most often occur near the bottom of the clay beds, and stones are most frequent in the upper part. The folding and unconformity can be observed at Saugus and Haverhill, Massachusetts; at Portland and Augusta, Maine, and elsewhere. The presence of till both above and below the clay places it most probably in the interval between the Illinoisan and Wisconsin glaciations, and it may have been deposited at about the same time as the Iowan loess, to which its relations are rather similar.

10. Overlying the clay in some localities are a few feet of stratified sands, rising to the same general level as the clay, probably being a part of the same series. These, together with some of the Wisconsin sands, were called 'Saxicava sands' by the early geologists.

11. *Unconformity.*

12. *A Few Feet of Till.*—This till generally occurs as a thin deposit three to ten feet in thickness, but occasionally seems to be thickened up in the form of drumlin-like deposits amounting to as much as fifty feet. It is generally more gravelly than the Montauk type of till, and the oxidation does not often extend over three to five feet from its surface. This till can be seen resting on clays and gravels throughout this part of New England, but the best section is probably in the vicinity of Augusta. This till is believed to be the true Wisconsin till of New England.

13. *Retreatal Deposits of Sand, Gravel and Local Clays.*—These occur over wide areas in Massachusetts, New Hampshire and southern Maine. They were formed in part in glacial lakes and in part as outwash deposits in the sea or above water level.

14. *Deposits of Local Glaciers.*—In several localities in Maine: (*a*) In the territory directly east and southeast of Mt. Katahdin in northern Penobscot County, (*b*) in the mountainous region between Bangor and Ellsworth in Hancock County, and (*c*) in southern Piscataquis County, there is considerable evidence from direction of striæ, amount of oxidation, position of moraines, etc., indicating probable local glaciations somewhat later than the Wisconsin ice advance.

In closing this abstract the writer wishes to acknowledge his indebtedness to Mr. G. C. Matson, who assisted him in the underground water investigations and obtained many data helping towards a solution of Pleistocene problems.

FREDERICK G. CLAPP.
UNITED STATES GEOLOGICAL SURVEY.

CURRENT NOTES ON METEOROLOGY.

THE FIRE-SHIP OF BAY CHALEUR.

IN his 'Notes on the Natural History and Physiography of New Brunswick' (*Bull. Nat. Hist. Soc. New Brunswick,* xxiv, Vol. V., 1905) Professor W. F. Ganong has a short paper, 'On the Fact Basis of the Fire (or Phantom) Ship of Bay Chaleur.' After an examination of all the evidence it appears to the author plain (1) that a physical light is frequently seen over the waters of Bay Chaleur and its vicinity; (2) that it occurs at all seasons, or at least in winter and summer; (3) that it usually precedes a storm; (4) "that its usual form is roughly hemispherical with the flat side to the water, and that at times it simply glows without much change of form, but that at other times it rises into slender moving columns, giving rise to an appearance capable of interpretation as the flaming rigging of a ship, its vibrating and dancing movements increasing the illusion." This is doubtless a manifestation of *St. Elmo's Fire,* but the compiler of these notes is not aware of any reports of similar phenomena, of such frequency in one locality, and of such considerable development. Professor Ganong cites the case of some lights reported around Tremadoc Bay in Wales, but notes that they in all probability had only a subjective basis. Lights of unexplained origin, the author notes, were reported as common off the Welsh coast two hundred years ago, and mention is made of St. Elmo's Fire observed at Anticosti. The phenomenon described by Professor Ganong is an interesting one, well worthy of careful study.

MONTHLY WEATHER REVIEW.

The Monthly Weather Review (No. 5, 1906) contains the following papers of general interest: 'Present-Day Climates in their Time Relation,' by F. M. Ball, of the University of Minnesota, a brief review of some of the more important facts regarding climatic changes, with the emphasis on geological changes. 'Severe Hailstorm in the Gulf of Mexico,' reported by R. G. Bindley, officer of the S. S. *Jamaican.* This storm occurred on March 18 last; the hail was so heavy that the ship was stopped and the officer of the watch and the helmsman were compelled to seek shelter. The first officer received a severe bruise caused by a hailstone striking the back of his neck, and the helmsman received a scalp wound. The stones dented the binnacles and chipped paint off rails and other painted surfaces. 'Tornado in Australia,' an account based on notes by H. A. Hunt, government meteorologist of New South Wales. This tornado was

a mild form of the American phenomenon of the same name. It occurred at North Sydney, March 27 last, in the region of northeast cyclonic winds, and moved southeast. This is the region which corresponds to the usual part of a cyclonic area in which our tornadoes occur.

BÖRNSTEIN'S 'LEITFADEN DER WETTERKUNDE.'

ONE of the most useful text-books of recent years is Börnstein's 'Leitfaden der Wetterkunde,' the first edition of which was published in 1901. This excellent little volume has now come to a second edition (Berlin, 1906), and has been brought thoroughly up to date. It in no way trespasses on the ground covered by any other of the newer text-books, and is unique in presenting an extraordinary richness of material, in a clear, compact form, with an admirable list of references to publications where further details may be sought. In the new edition special attention is paid to the temperature conditions and movements of the upper air, and to other subjects upon which recent studies have thrown much light. We note an interesting view (Fig. 14) of the upper surface of a sea of clouds, in which the course of underlying rivers is indicated by breaks; the inclusion of Berson's excellent classification of the different atmospheric strata in relation to vertical temperature gradients (p. 35); and the beautiful colored cloud views, Pls. V.–XV.

THE CYCLONIC THEORY.

W. H. DINES, who has been active in the prosecution of kite meteorology, says (*Nature*, 1906, 35–36) that the results of some two hundred kite ascents which he has carried out in England and Scotland, with an average height of about one mile, seem to give no evidence either for or against the convectional or 'driven' theory of cyclones. Dines believes that an error has been made in working out the results of free-air observations in cyclones and anticyclones. In a gas in equilibrium, he says, under a conservative system of forces, the isothermal and isobaric surfaces must be identical. The temperatures in cyclones and anticyclones should, therefore, not be compared at the same height, but on the same isobaric surfaces. In temperate latitudes these surfaces may differ from surfaces of equal height above sea level by a thousand or more feet.

'SOME FACTS ABOUT THE WEATHER.'

UNDER the above title, Mr. William Marriott, assistant secretary of the Royal Meteorological Society (London), has published a little handbook of thirty-two octavo pages, at the price of sixpence (London, Stanford, 1906). The text covers about the ground of a 'popular' lecture on meteorology, but is especially adapted for use in the British Isles.

R. DEC. WARD.

YALE UNIVERSITY.[1]

OUR constant growth in numbers and our recent increase in endowment ought to enable us to do better work in the future than we have done in the past. A progressive university should make the maintenance and improvement of its standards its chief concern. It must be recognized as a place where truth is discovered and taught. I propose to discuss some of the means by which we can reach this end.

In dealing with the question of university organization, we can divide our members into three groups: (1) heads of departments; (2) other instructors and graduate students; (3) undergraduates in the various courses, liberal or professional. This is not the conventional line of division, but it is the one which best serves our present purpose.

Heads of departments ought to be fewer in number, and better paid. This is probably true of American universities as a class; it is certainly true of Yale. We have too many full professors, and, partly as a consequence of this, we pay them too small salaries. If we see a store or factory where there are a large number of more or less separate departments whose heads receive low salaries, we believe that the business is being wrongly administered. It is not always safe to draw too close analogies between industrial work and

[1] From the report of President Hadley.

educational work, but in this case I believe the parallel holds good.

The first step toward reform is to recognize the principle that no man should be appointed to a full professorship in any subject merely because that subject needs to be taught. If there is a man of eminence in the subject who has a genius for discovery or teaching, the fact that such a gap exists creates an additional reason for calling this man to a professorship. But if no such man is to be found the place should be filled by an assistant professor. The fact that we have departed from this principle in the past, and now have on our faculties as full professors a number of men who ought to be only assistant professors, does not alter the necessity for a change of policy in this respect. I am glad to say that nearly all the members of the several faculties of the university cordially accept the principle here laid down, and are willing to try in future to appoint none but a first-class man to a grade higher than an assistant professor, even though this policy may for the moment apparently weaken the strength of our teaching force. This weakening will be apparent rather than real. There is nothing which really weakens the teaching force so much as the permanent appointment of a man of the wrong type, who lowers the standard held before the students and blocks promotion among the younger instructors. It is far better to have a subject taught by ambitious young men who see an opening ahead than by a somewhat older man who has little to recommend him except his maturity.

With the diminution of numbers, an increase of salaries can follow as a matter of course. This process has already begun, and many of the professors who have hitherto received $3,750 are now to receive $4,000. But this should be regarded as only a beginning. Just as soon as the university finances admit it, there should be a further increase to $4,500, and then to $5,000 or even $6,000. There should also be an increase in the number of assistants, who can relieve the professor of the burdensome necessity of reading papers or directing some of the details of individual study. If a professor is really able and mature, the ideal method is not to give him a division of forty or fifty or sixty, as we used to, with a class-room which would be partly examination and partly lecture, but to let him talk all at once to as many students as possible, be it two hundred or five hundred; and then have these men met as often as once a week in very small groups by a younger instructor, who can talk over the work that they are doing and examine the progress that they are making. Both here and at Harvard this scheme has increased both the teaching efficiency and the financial economy.

We must, however, guard ourselves against the danger of creating a separate or privileged class of research professors. In some universities there is a tendency to set some men apart for discovering new truth, while employing other men to teach old truth. This is a mistaken policy. We are not dealing with an ordinary case of division of labor. The chief argument for division of labor is that it makes each man more expert and more efficient in his own field of work. In university work, however, the man who tries to investigate without teaching is apt to become sterile, while the man who attempts to teach without investigating becomes a worse teacher instead of a better one. We want the opportunities for research and investigation distributed as widely as possible throughout the teaching force and the student body. We want to impress upon every man that teaching and discovery are both done at their best when done in combination. Not that every man should be compelled to lecture to classes, whether he is able to do so or not. There is a great deal of valuable teaching which is not done in the class-room, or even in the laboratory. There are some men who teach best by their writings, their conversations, their intelligent suggestions for the work of others; but they should understand that they are part of the teaching force, and are simply doing their teaching in a different way from other men. Instead of setting such a man apart as a research professor, we should let him understand that withdrawal from the lecture room and relief from the

duties of supervising elementary students carry with them a larger obligation to publish as fully as possible the results of all discoveries; to organize departments intelligently; to train up young men who can teach; and to make liberal room for such men, instead of trying to get in their way when their work becomes popular.

These last statements indicate the policy which we should adopt in dealing with our junior instructors and graduate students. We should give them the maximum of freedom consistent with their teaching duties. We can not, under the existing circumstances, pay them as large salaries as we should like to do, or as the work of many of them deserves; but we can at least give them a fuller chance to show what they have in them. In the time which is necessarily occupied by class-room work we can allow them more independence of method than has been habitual in the past. If we have as heads of departments men who are competent to look after results we can leave their assistants the utmost freedom in the choice of means. We can make a university a good place for an instructor or student of any grade who thinks that he has something to discover. If we keep places free at the top we increase his opportunity for promotion if his discoveries turn out as he expects; and if promotion does not come here we can always find chances for him elsewhere. Of course there will be among the members of the teaching force many a man who disappoints us, and perhaps disappoints himself; but if one of his superiors—president, dean or head professor—gives him timely warning that we shall not be able to promote him here, it is easy to find such a man a teaching place elsewhere without grave hardship to him and with definite advantage to the university.

The success of a system of this kind is to some degree dependent upon the laboratories and library facilities accessible to the different instructors. But a laboratory or library of moderate size, administered in the right spirit, is far more efficient than a much larger one which is monopolized by a few heads of departments for their own special investigations. It is astonishing what an amount can be done with very moderate facilities by a group of young men working together, animated by the spirit of independent investigation for the moment and by the prospect of distinction for the future. In each new laboratory that we establish, or in each new appointment to the headship of an old laboratory, we set forth clearly the fact that it is to be open to the use of junior instructors and graduate students just as far as the circumstances allow, to work in the way that they think promising rather than in the way that the chief thinks promising. This will result in a good many mistakes, and in some waste which might have been avoided; but it will result in vastly increased efficiency and in a great many discoveries which would otherwise have been prevented.

Mr. Schwab, in his position as head of the library, is fully in sympathy with these ideas; and the addition to the library building, erected from the bequest of William B. Ross, as a memorial to Jared Linsly, is being arranged with that end in view. There is no other institution connected with the university whose administration affects the efficiency of so many departments. Yale is to be congratulated on what Mr. Schwab is accomplishing and also upon the care and intelligence shown by Mr. Haight, the architect of the new building, in enabling us to achieve the most with the means at our disposal.

A committee of the university council is arranging plans for increased opportunities for publication of new discoveries in various lines—a matter in which during recent years our facilities have been inadequate. This is a thing of great importance as a stimulus to the older students and younger instructors. The full professors have so much reputation that they can publish their work anywhere, and proper attention will be given to it; but for the men who still have their reputation to make, the opportunity for a convenient and quick channel of publication is a great stimulus to the work and a great help to the university with which their published work is identified. Nothing in times past did more

for the development of the scientific spirit at Yale than the fact that Silliman's *Journal of Science,* for many years the one high grade American periodical of its kind, was published here. In other lines we have not kept up to the traditions set by Professor Silliman, and have suffered from it rather severely; but it is by no means too late for recovery.

The independence of the different faculties at Yale is in some respects a help, and in other respects a hindrance, to our investigators. It is a help in that it helps to keep alive the traditions of academic freedom. It is a hindrance in that it sometimes prevents the most effective cooperation between the laboratories of different departments.

A thing which is an unmixed help in every way, and should not be overlooked in any discussion of Yale's advantages, is the Graduates' Club. By furnishing a center in which instructors and students of all grades and visitors from abroad meet informally on a plane of social equality, it tends to diffuse the spirit of academic freedom and academic progress. It adds immensely to the attractiveness of New Haven as a place for the ambitious investigator, be he student or instructor, and does more than any other one thing to help the formation of that indefinable thing called a university atmosphere. The Graduates' Club was not organized with this end in view. If it had been, it probably could not have accomplished the result so effectively.

SCIENTIFIC RESEARCH.[1]

A COLLEGE, as the word is usually understood in America, is a school of general training. Its work is found to be the more effective the better it is fitted to the traits of the individual, but in the nature of things its work with the individual is not limited to a narrow range of subjects. The university is a school of instruction through investigation. Its characteristics are advanced research and specialized development. As matters are, the faculty of the American university has to deal with two sets of students and two classes of instruction, those of the college and those of the university. But in both cases it is for the university to set the standard. To the university teacher, individual research is the breath of life, and it is the duty of the institution in every reasonable way to foster its development.

In the practical consideration of this problem we may take the following propositions as granted:

1. A few men, and but a few, even in the greatest universities, ever contribute very much to the direct advancement of science.

2. No one can be a great teacher without the spirit of research; without this he lags behind the progress of knowledge, and his mental equipment becomes second-hand.

3. With most men the practical purpose of research is that they may be better teachers.

4. With most men a reasonable following of students is an aid to research, not a hindrance.

5. Those who feel called to research, but who can not or will not teach, should in general look outside the university for careers, at least until they have clearly proved their eminence.

6. The university should recognize the superior teacher or investigator by relieving him, as far as may be, of administrative drudgery, which uses up time and strength more than teaching does. Every active worker should have what he needs in the way of help of stenographers, artists, readers, curators, mechanics and the like. A man of choice powers should not waste his time on what cheap men can do. It is often best to relieve the ablest men in the department from its executive responsibility.

7. It is desirable that a university should publish the results of completed investigations of its professors, and do this in first-class form. Such publication in worthy manner is a stimulus to good work. But material brought together under stress of demand for publication is best left unprinted.

[1] From the annual report of President David Starr Jordan, Stanford University.

A MEMORIAL TO HERBERT SPENCER.[1]

A SHORT time ago a petition was presented to the Dean of Westminster asking permission

[1] From *Nature.*

to place in Westminster Abbey a memorial tablet commemorating the life and influence of Mr. Herbert Spencer, but though the appeal was supported by many men of science and letters it was rejected. The reason why the Dean withheld his consent to this unobtrusive memorial of a great philosopher is not clear; and the *Daily Chronicle* has recently revived interest in the movement with the object of inducing him to reconsider his decision, or, failing this, to secure some other national memorial of Spencer's work. From the opinions of a number of distinguished men published in our contemporary, it is evident that much disappointment is felt at the failure to find a place in the Abbey for a simple memorial tablet to Spencer, but there is a difference of opinion as to whether steps should be taken to establish a national memorial to him in some other form. Among the men of science who consider it would be a reproach to leave Spencer's memory unhonored are Lord Avebury, Professor Clifford Allbutt, Dr. Bastian, Sir Michael Foster, Mr. Francis Galton, Sir Joseph Hooker, Professor M'Kendrick and Professor Poulton. There is, however, a strong feeling, expressed by Sir Norman Lockyer, that while no national memorial to Darwin exists outside Westminster Abbey, it would be undesirable to attempt to raise one to Spencer by public subscription. Lord Kelvin goes so far as to remark: "I have never been of opinion that the philosophical writings of the late Mr. Herbert Spencer had the value or importance which has been attributed to them by many readers of high distinction. In my opinion, a national memorial would be unsuitable." Sir William Huggins also hesitates to support a general movement to provide a national memorial, though he agrees that a memorial tablet in the Abbey would appropriately commemorate Spencer's work. In the absence of this form of recognition, it would seem that the best way for admirers of the philosopher to show their appreciation of his work would be to establish a lectureship or scholarship in sociology, natural science, or principles of education, to issue, as suggested by Dr. A. R. Wallace, a cheap edition of his works, or in some other manner to further the objects to which he devoted his life. A movement with an end of this kind in view might be made of international interest, and would doubtless receive liberal support.

AREAS OF THE UNITED STATES, THE STATES AND THE TERRITORIES.

The question, 'What constitutes the area of the United States?' is discussed in Bulletin 302 of the United States Geological Survey, of which Mr. Henry Gannett is the author. Jurisdiction extends to a line three nautical miles from the shore, but this strip of sea can not properly be regarded as a part of the country. Supposing our country to be restricted to the sea and lake coast, there remains a question regarding the bays and estuaries. To what extent should the coast line be followed strictly, and where should we begin to jump across the indentations made by the sea? In this matter one can only follow his own judgment, making in each case as natural a decision as possible, as no definite criterion can be established. The absence of an absolute standard is in large measure the cause of the discrepancy between the tables of the Census Office, made in 1881, and those of the General Land Office, prepared in 1899, both of which show the areas of the United States and of the several states and territories.

The measurements and computations upon which these tables were based were made with great care and thoroughness in each case, and the results probably represented the areas as closely as they could be determined from the maps and charts in existence at both times. Most of the differences in these two sets of tables are trifling, amounting to only a few square miles or a small fraction of one per cent., being well within the limits of error of the planimeter and of the maps used. Some of them, however, are considerable, and a few are explained by the fact that more recent maps, which changed the position of boundaries between states, had been used by the Land Office, and its measurement was, therefore, more nearly correct. Other discrepan-

cies arose from differences in determining the coast lines.

Realizing the desirability of but one government statement of areas of the states and territories, an attempt has been made by Mr. Frank Bond, chief draftsman of the General Land Office; Mr. C. S. Sloane, geographer of the Census Office, and Mr. Henry Gannett, geographer of the Geological Survey, to come to an agreement on these figures. The results of their conference and cooperation are set forth in the aforementioned bulletin.

By this adjustment the area of the United States proper, which is given as 3,026,789 square miles, is increased over the Census Office figures by 1,188 square miles.

The area given for Alaska is 590,884 square miles. It is subject to considerable modification in the future as the position of the coast line becomes better known. The area given for the Philippine Islands is 115,026 square miles, and was determined by the Coast Survey of that archipelago, prepared at the instance of the Philippine Census. It also is subject to modification as accurate charts of the archipelago are made. The areas of Hawaii, 6,449 square miles, and Porto Rico, 3,435 square miles, are probably subject to only slight changes, as the charts from which they were measured are quite accurate. The areas given for the other small possessions of the United States, Guam, 210 square miles; Samoa, 77 square miles, and the Panama Canal strip, 474 square miles, will probably be changed in the future as their limits become more correctly defined.

SCIENTIFIC NOTES AND NEWS.

AT the last meeting of the Rumford committee of the American Academy of Arts and Sciences, the following grants for research were made: $300 to Professor Arthur A. Noyes, of the Massachusetts Institute of Technology, for the construction of a calorimeter for the determination of heat reactions at high temperatures; $200 to Professor Robert W. Wood, of Johns Hopkins University, for the continuation of his researches on the optical properties of sodium vapor.

MR. ALFRED AKERMAN, state forester of Massachusetts, has resigned to accept the Peabody chair of forestry recently endowed in the University of Georgia. He is succeeded by Professor Frank Wm. Rane, professor of horticulture and forestry at the New Hampshire College. Mr. Rane's present address is, Room 7 State House, Boston, Mass.

MR. GEORGE A. COLEMAN, M.S. (Stanford, '05), has been appointed forest supervisor in charge of the Shasta Reserve.

DUDLEY MOULTON, M.S. (Stanford, '06), at present stationed in Nebraska investigating the codlin moth, has been appointed field assistant in the U. S. Bureau of Entomology.

PROFESSOR MANSFIELD MERRIMAN, Ph.D., head of the department of civil engineering, of Lehigh University, has been granted a year's leave of absence. He will reside in South Bethlehem and will attend to the administrative duties of his department.

A COMPLIMENTARY luncheon to Professor Ronald Ross, C.B., Professor R. Boyce and Dr. J. L. Todd, in recognition of the decoration recently conferred on them by the King of the Belgians for the work done by the Liverpool School of Tropical Medicine, was given on October 1 by the Lord Mayor of Liverpool.

PROFESSOR RAYMOND H. POND, of the Northwestern University, has been awarded a research scholarship at the New York Botanical Garden for six months, beginning October 1.

THE Duke of Abruzzi is planning an expedition to the Himalaya Mountains.

DR. JOHN GIFFORD is now engaged in delivering ten lectures on 'Tropical Pomology,' at Cornell University.

M. PIERRE JANET will shortly give a course of fifteen lectures at the Harvard Medical School on 'The Symptoms of Hysteria.'

THE Harvey Society of New York announces its second course of lectures. These are given at the Academy of Medicine building, 17 West 43d Street, on Saturday evenings at 8:30 P.M. The lectures are open to the public and all interested are cordially invited to attend. The program for the year is as follows:

October 20, Professor A. E. Wright, London: 'Therapeutic Inoculation with Bacterial Vaccines.'

November 3, Professor C. A. Herter, New York: 'The Common Bacterial Infections of the Digestive Tract and the Intoxications arising from them.'

November 17, Professor W. T. Porter, Boston: 'Vasomotor Reflexes.'

December 1, Professor J. G. Adami, Montreal: 'The Myelins and Potential Fluid Crystals of the Body.'

December 15, Dr. S. J. Meltzer, New York: 'The Factors of Safety in Animal Structure and Animal Economy.'

January 12, Professor F. G. Benedict, Middletown, Ct.: 'Metabolism during Fasting.'

January 26, Professor E. B. Wilson, New York: 'Recent Studies of Heredity.'

February 9, Professor G. S. Huntington, New York: 'The Genetic Interpretation of Variations in the Genito-Urinary Tract.'

February 23, Professor W. T. Councilman, Boston: 'The Relation of Certain Leucocytes to Infectious Diseases.'

March 9, Professor Friedrich Müller, Munich: 'Neuroses of the Heart.'

The autumn lectures to be delivered in the lecture hall of the museum building of the New York Botanical Garden, Bronx Park, on Saturday afternoons, at 4:30 o'clock, are as follows:

October 13, Dr. W. A. Murrill: 'A Summer in Europe; Some Foreign Botanists and Botanical Institutions.'

October 20, Dr. M. A. Howe: 'The Vegetation of the Florida Keys.'

October 27, Dr. C. Stuart Gager: 'How Plants Breathe.'

November 3, Dr. Arthur Hollick: 'Coal: Its Origin and Development.'

November 10, Mr. G. V. Nash: 'The Vegetation and Botanical Features of the Inaguas and Grand Turk, Bahamas.'

November 17, Dr. N. L. Britton: 'Recent Explorations in the West Indies.'

November 24, Dr. H. H. Rusby: 'The Wild Nuts and Grains of North America.'

In order to provide a method for viewing the collections of the garden under guidance, an aid will leave the front door of the museum building every week day afternoon at three o'clock, to escort all who may wish to accompany him. The routes will be as follows: Monday, hemlock forest and herbaceous garden; Tuesday, pinetum; Wednesday, fruticetum and north meadows; Thursday, deciduous arboretum, nurseries, propagating houses; Friday, public conservatories; Saturday, museums.

We learn from *Nature* that the council of the Institution of Civil Engineers has, in addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, made the following awards in respect of other papers dealt with in 1905–6: A Telford gold medal to Mr. G. A. Denny; a George Stephenson gold medal to Professor W. E. Dalby; Telford premiums to Messrs. W. R. Baldwin-Wiseman, G. N. Abernethy, H. R. C. Blagden, M. R. Collins and James Kelly; a Crampton prize to Mr. P. T. Gask. For students' papers the awards are: Miller prizes to Messrs. Ralph Freeman, A. F. Harrison, A. J. Grindling, T. R. Grigson, J. W. D. Ball and A. Morris. Mr. A. F. Harrison also gained the James Prescott Joule medal. The awards will be presented on November 6, when an inaugural address will be delivered by the president, Sir Alexander B. W. Kennedy, F.R.S.

Professor C. A. J. A. Oudemanns, who formerly held a chair of botany at Amsterdam, has died at the age of eighty years.

Sir Richard Tangye, head of a large engineering firm at Birmingham and the author of books on travels and industry, died on October 14, at the age of seventy-three years.

The widow of the late Professor Gusserow would like to sell his library as a whole. The library is a very rich one and contains sets of archives, of society publications, text-books and separate volumes, and also about 4,000 separate reprints. A catalogue has been prepared of the library, the value of which has been estimated at 14,000 Marks. Further inquiries on the subject may be addressed to Professor Waldeyer, 35 Luther Strasse, Berlin, W., Germany.

Through the generosity of friends the Chicago Academy of Sciences has secured 3,000 species of the Quadras collection of Mollusca, which was exhibited at the St. Louis World's

Fair. The species are mostly from the Philippine Islands, many of them being topotypes from the original lots named by Moellendorf, Hidalgo and Quadras.

THE botanical department of the University of Illinois has purchased the herbarium of George D. McDonald, of Peoria, Ill. It contains about 12,000 specimens.

IN a letter from the Congo Free State Major P. H. G. Powell-Cotton states that he has succeeded in obtaining the skeleton and skin of a fine male okapi. This animal was killed at Makala, in the Ituri forest, by the native hunter Agukki, who shot the two specimens taken to Europe by Dr. David.

THE U. S. Department of Agriculture has leased from Dr. John Gifford seven and a half acres on Elliott's Key, Dad Co., Florida, for ninety-nine years for the purpose of experimenting with tropical plants.

IT is stated in *Nature* that the authorities of the Clifton Zoological Gardens, Bristol, have recently made considerable improvements designed for the increased comfort and display of their collections. Two years ago a new lion house was built, having the cages within communicating with four open-air ones iron-barred on three sides. The animals placed in these cages showed so distinct a preference for the open air, and improved so materially, that the older range of houses has been entirely reconstructed, and was thrown open to the public on Saturday, September 22, for the first time. As now reconstructed, seven open-air cages are placed along the front of the old house, and communicate with the dens within. The cages are lofty, being between ten feet and twelve feet in height, about twelve feet wide, and fourteen feet long. They are supported upon a brickwork base four feet in height, and separated from the public by a stout iron rail, placed three feet away from the cage fronts. It is noteworthy that a Rhesus monkey was formerly kept in an outer cage in the gardens for quite a number of years, winter and summer alike, and fared well even in hard frost and snow. When taken into the monkey house, however, it quickly sickened and died.

The Electrical World quotes the following figures on the patent office congestion compiled by Mr. F. W. Barnaclo, of New York City. The office seems sorely in need of more men at better pay, for which the annual profits seem quite adequate. Mr. Barnaclo's investigation shows that in January last there were 17,353 applications awaiting action in the 39 divisions of the patent office. To date there are 24,000 cases on the docket which have not been reached for examination, and tabulations prepared by the attorney show that the office is falling behind from 250 to 300 cases a week. It is shown in the records that the average number of applications filed a week is from 800 to 1,200, and there are only about 600 patents issued a week. Among divisions behind are the following: Hydraulic motors, pumps and sewerage appliances, 11 months and 23 days behind and 1,029 cases on hand. Air and gas engines, pumps and pneumatics, 10 months behind and 993 cases on hand. Machine tools, 7 months and 19 days behind and 675 cases on hand. Elevators, journal boxes, lubricators, machine elements, pulleys and shafting, 4 months and 17 days behind and 657 cases on hand. Annealing, tempering and coating in metals, electrochemicals, metal founding, metallurgy, etc., 3 months behind and 375 cases on hand. Electric conductors, electric appliances, lighting, etc., 11 months and 7 days behind and 1,069 cases on hand. Steam engineering, 4 months and 23 days behind and 472 cases on hand. Motive power, 5 months and 25 days behind and 613 cases on hand.

AT the University of Leeds the inaugural address of the new session was delivered by Sir James Crichton-Browne upon the subject of 'Universities and Medical Education.' In the course of his remarks, as abstracted in *Nature*, he said that centuries ago gifts were given for the promotion of objects equivalent to those which modern universities hold in view, which, considering the pecuniary resources of those who gave them, should put our most open-handed modern millionaires to shame. England has been remiss of late in perceiving and promoting those interests that

hinge in scientific and medical research. In this direction Germany has stolen a march upon us, for the various governments in that empire have unstintedly provided their universities with fully-equipped research laboratories, organized and conducted by professorial directors. A university is something more than a medical school, a workshop of research, or a home of science. It must have loftier aims than material advancement or commercial prosperity. It must provide for culture in its widest sense, afford intellectual guidance, encourage individuality, take cognizance of the theoretical problems that arise in the progress of civilization, be a storehouse of knowledge, and a gymnasium for the exercise of all the powers of the mind and to be truly a university it must be an organism, and not a mere conglomeration of parts. The one great objection to the multiplication of universities is that they may tend to become local seminaries, somewhat parochial in spirit, and fed exclusively from one district, for it would be a misfortune to a boy to pass from a secondary school to a university in the next street, where he would meet as his fellow-students only his old schoolfellows, and where, however amply fed with knowledge, he would still be surrounded by the same traditions and associations and shop amongst which he had been brought up. A provincial university is a contradiction in terms. What is wanted is a group of territorial universities, each with distinctive features of its own, specially adapting it to its environment, but all affording the most liberal instruction, the finest culture, the best intellectual discipline of the day, and collectively meeting the higher educational needs of the whole country.

The Geographical Journal states that Sir Everard Im Thurn, governor of Fiji, made a journey last November across the mountainous interior of Viti Levu, from the mouth of the Sigatoka River on the one side to Ba on the opposite coast. The coast at the river-mouth is unprotected by a reef, and the big ocean waves locally called *lokas*, continually roll in, making the narrow rocky entrance precarious even for small boats, and piling up the great swelling sand-dunes characteristic of this part of Fiji only. An entrance was, however, successfully made in the steam-launch of the *Ranadi*, perhaps the first steam-craft to enter the river. After presiding at the installation of a new Roko, or native chief, the governor and his party proceeded along the bridle-road which crosses the flats of the Sigatoka and winds over the rugged interior ranges. The flats, which extend up to Fort Carnarvon, seem capable of great development agriculturally. The route led through the scenes of the war of 1876, in which Sir Arthur Gordon finally ended the long strife waged by the mountain tribes against the coast natives and Europeans. On the present occasion the travelers met everywhere with a most hospitable reception, and the outer hills struck the governor as offering great opportunities for sheep-rearing, if the native system of firing the whole country-side in search of wild yams were stopped. Further on the Nalotu range, with a wonderfully serrated crest of dolomitic rock, was crossed by a small but well-marked nick in the knife-edge, the steep descent leading through thick trees to the flats along the Ba River. On this, the northwest side of the island, is the great sugar estate of the Colonial Sugar Refining Company, extending some forty miles between the Ba and Nadi rivers, the capabilities of which considerably impressed the governor. At one of the more recently opened centers, Lautoka, the mill is one of the most up-to-date in the world, and the place has also the advantage of possessing sheltered anchorage and an excellent wharf. What is wanted, however, is the connection of its tram system with that at the other end of the estate. An interesting experiment in the reclamation of coast swampland has lately been made, the great difficulty being the washing of the salt out of the soil. From Ba the governor rode up by the excellent bridle-path to Nadarivatu (which it is hoped to develop as a sanatorium), through some of the finest mountain scenery imaginable.

Nature states that the committee of the Quekett Microscopical Club has arranged for

a series of demonstrations at 20 Hanover Square, W., on 'The Practical Use of the Microscope and its Accessories,' to be given from 7 to 8 P.M. on the third Friday in each month during the ensuing session. The first will be on November 16, when Mr. H. F. Angus will deal with axial substage illumination, including the use of the plane and concave mirrors, substage condensers and methods of centering the illuminant and of obtaining critical illumination. At other demonstrations, the order of which is not yet finally settled, the following subjects, among others, will be considered: substage non-axial illumination, including oblique and dark ground illumination; the use of the micropolariscope; various methods of illuminating opaque objects; the testing and comparison of objectives; and the employment of micrometers and finders. These demonstrations will be in addition to the 'Gossip' meetings of the club, which are held on the first Friday, and to the ordinary meetings, held also on the third Friday of the month at 8 P.M.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. ALFRED C. CHAPIN has given Williams College, of which he is an alumnus, an additional gift of $50,000, to be used by the trustees without restriction. Another New York alumnus, Mr. Charles T. Barney, has given $10,000 to the college.

THE Oberlin correspondent of the New York *Evening Post* states that the half-million fund for Oberlin College, as completed, amounts to $501,608. This is divided under the following funds: $125,000 for a new library building given by Mr. Andrew Carnegie, $100,000 for library endowment, $100,000 from an anonymous donor in Boston for the increase of salaries of teachers in the college and seminary, $25,000 for an art building and its endowment, $5,000 for the Barrows' Memorial Building for Men, and $146,608 for miscellaneous purposes. The gift of the Boston donor enables the trustees to increase by $200 the salaries of twenty-four full professors. The amount of the $146,608 is devoted to the following objects: $85,000 given by Miss Anne Walworth for the endowment of the Slavic department, $15,000 given by Mr. F. Norton Finnery as an addition to the Finney Memorial Chapel fund, $21,558 for equipment and endowment in various departments, and $25,000 for new scholarships and loan funds. Of this, $10,000 is in scholarships for self-supporting women, and $10,000 is in the Gilchrist banking fund, the income of which may be used as temporary loans to students. This fund was a bequest from Ella Gilchrist Potter, of Alpena, Mich. The largest single gift toward the library endowment was that of Dr. C. N. Lyman, of Wadsworth. This amounted to $34,000. The remaining $66,000 was given by fifty-five donors in sums ranging from $10,000 to $25.

THE facilities of the engineering department of Purdue University have been increased by the completion of a building containing three floors, each 75 x 130 feet, for the department of civil engineering, and by an addition to the electrical laboratory 68 x 90 feet to give room for additional equipment. This room is to be served by a traveling crane which may be utilized in transferring heavy equipment from the laboratory to a new lecture room which adjoins. There have been added to the materials testing laboratory and to the steam engine laboratory a number of machines, including a 100,000-pound Olsen testing machine, a Fairbanks-Morse 50 horsepower gas producer and gas engine, a 20 horsepower DeLava steam turbine with direct-connected centrifugal pump, a steam Ingersoll-Rand air compressor, a Foster super-heater of the type supplied by the Power Specialty Company, a Gerry-Emmons gasoline engine, an Abner Doble water motor, and an Allis-Chalmers 8 x 24 Corliss engine, direct-connected with a centrifugal pump of 4,000 gallons capacity.

PROFESSOR W. C. SABINE, who holds a chair of physics at Harvard University and is known for his researches in acoustics and optics, has been appointed dean of the Lawrence Scientific School to succeed the late Professor Shaler.

DR. W. B. CANNON, assistant professor of physiology in the Harvard Medical School,

has been promoted to the George Higginson professorship in succession to Professor H. P. Bowditch, who has become professor emeritus. Dr. Wm. T. Porter has been promoted from an associate professorship of physiology to a chair of comparative physiology.

The administrative board for the Graduate School of Arts and Sciences of Harvard University for 1906–7 is as follows: Professors W. M. Davis, acting dean, E. L. Mark, G. F. Moore, H. W. Smyth, G. L. Kittredge, Hugo Münsterberg, W. C. Sabine, Maxime Bôcher, E. F. Gay, J. A. Walz.

Mr. W. L. Puffer, associate professor of electrical engineering at the Massachusetts Institute of Technology, has resigned and is succeeded by Professor George C. Shaad, of the University of Wisconsin.

Professor E. H. Sneath has been granted a second year's leave of absence from Yale University. Dr. Paul Monroe, professor of the history of education at Teachers College, Columbia University, will have charge of one of his courses.

Dr. Ira D. Cardiff, assistant in botany at Columbia University for the past two years, has resigned to accept the professorship of botany in the University of Utah, Salt Lake City, Utah.

Mr. Chester A. Darling, A.B. and A.M., now of Defiance College, Ohio, has become assistant of botany at Columbia University.

The following appointments are announced at Cornell University: J. C. Peebles, H. W. Riley, M. F. Thomas, George Carpenter and W. H. Van Winkle, instructors in experimental engineering; F. H. Kroger, instructor in electrical engineering; D. C. Gillespie, instructor in mathematics; Lowell B. Judson, assistant professor of horticulture.

At Dartmouth College, appointments have been made as follows: *Assistant professors,* Dr. D. H. Gerould, biology; Dr. G. M. Poor, astronomy. *Instructors,* R. M. Barton and F. C. Moore, mathematics; A. H. Chivers, biology; Dr. C. H. Johnston, philosophy. *Assistants,* F. L. Adams and C. Sheard, physics.

The following advancements in the teaching staff of Lehigh University have been announced: Assistant Professor Arthur E. Meaker, C.E., and Assistant Professor Preston A. Lambert, M.A., become professors of mathematics, and John H. Ogburn, C.E., assistant professor of mathematics; Assistant Professor John D. Irving, Ph.D., becomes professor of geology; Assistant Professor Philip M. Palmer, A.B., becomes professor of modern languages and literatures; Barry MacNutt, E.E., M.S., becomes assistant professor in physics; Assistant Professor William B. Schober, Ph.D., becomes acting professor of chemistry in charge of the department, in place of Professor William H. Chandler, Ph.D., resigned.

New appointments at Purdue University are as follows: W. K. Hatt, Ph.D., formerly professor of applied mechanics, to be professor of civil engineering in charge of the department; Mr. Paul B. Brenneman, B.S., 1894, C.E., 1897, State College of Pennsylvania, formerly engineer and superintendent of mining construction and operation, to be instructor in civil engineering; Mr. Arthur W. Cole, B.S., Worcester Polytechnic Institute, 1902, formerly of the University of Maine, to be instructor in thermodynamics; Mr. L. W. Wallace, B.S., Texas A. and M. College, 1903, late with the motive power department of the Santa Fe Railroad, to be instructor in car and locomotive design; Mr. W. T. Small, B.S., Purdue, 1903, formerly with the Cooper-Hewitt Electric Company, to be instructor in the electrical laboratory; Mr. C. E. Schutt, B.S., Purdue, 1905, formerly with the New York Telephone Company, Mr. George Lamke, B.S., University of Michigan, 1906, and Mr. W. A. Rush, B.S., Purdue, 1906, to be assistants in the electrical laboratory; Mr. R. D. Kneale, B.S., Purdue, 1906, and Mr. M. L. Allen, B.S., University of Wisconsin, 1906, to be assistants in the civil engineering department.

Mr. Robert E. Loving, Ph.D. (Johns Hopkins, '05), has been elected professor of physics at Cornell College, Iowa. Mr. Robert W. Getchell has been appointed assistant in the chemical department.

Professor Wien, of Würzburg, has declined the call to succeed the late Professor Drude, at Berlin, on the ground, it is said, that the government will not erect a modern physical laboratory.

SCIENCE

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THE TECHNICAL SCHOOL AND THE UNIVERSITY.

DURING the past four hundred years there has been a most significant although gradual development in the university organization. This has been a necessary result of the evolution of knowledge. The earliest continental universities found a reason for their being in the dissemination of a system of scholastic learning which had little to do with the affairs of men. A body of learning based chiefly if not wholly upon certain conventional systems of abstract knowledge like the Aristotelian logic, transmitted with little or no change from the masters of antiquity, constituted essentially all they had to offer to their students. The instruction consisted almost entirely of certain exercises in this intellectual inheritance practically unchanged through the centuries of its transmission. This mental training had essentially no relation to or bearing upon the actual things of human experience, nor had it much effect upon national life or upon any of the varied interests of the community.

In the beginning of the sixteenth century, however, when the dark shadows of the middle ages began to disappear before the illuminating influence of a truer knowledge, a remarkable movement began in a contest which has scarcely been closed to this day. The intense struggle between humanism and scholasticism began in and around the German universities in the early years of the sixteenth century. The

actors in this new culture rejected the old sterile instruction with merciless vigor and displaced it with systems of study touching as closely as possible the actual life of those times. It was their open purpose in which they gloried to treat of things as they actually existed, to get as near to the life of the community as the best knowledge would bring them; in other words, to touch human life intimately and at the greatest possible number of points.

Scarcely had the humanistic movement reached a successful issue, before it was supplemented by the reformation. Although this great religious upheaval was destined ultimately to aid the humanistic movement, an intense struggle marked the first stages of their concurrent development. While the ultimate effects of these two epoch-making movements were virtually the same in their influence upon the advancement of knowledge and upon the evolution of the university, the fundamentally different characters of their two great representatives led to intellectual contests of exceeding bitterness. Fortunately, however, their efforts to advance knowledge along these different lines created a common spirit of true learning, which has been the living stimulant of university life from that day until this.

During the sixteenth and seventeenth centuries the university may be said to have consisted of the philosophical and theological faculties, supplemented by the faculties of law and medicine. The subsequent extensions of the university throughout the eighteenth century resulting from its closer contact with the things disclosed by experience and its widening influence upon all branches of human activity, were chiefly marked by the strengthening of the faculties of law and medicine.

Throughout all this period of over three centuries the philosophical faculty was predominant in its position and influence in the university. It had come to represent a body of more or less abstract instruction covering by far the greater part of the existing field of human knowledge, and, it must be said, divorced largely from the real things to which it properly belonged. In the early history of universities it constituted a sort of purveyor of privileged or aristocratic learning ostensibly of better birth than the professional faculties of law and medicine, which had the misfortune to deal with the actualities of life on which the welfare and safety of communities no less than the rights and duties of individuals are fundamentally based. This conventional class distinction constituting a kind of snobbery of learning was the real influence or force so completely overcome by the movements of humanism and the reformation, and it has bequeathed to us the useless and senseless term 'pure' science as opposed to applied science; as if there could be in some way a science politely distilled as an essence of learning separated from the realities with which absolutely all science whatever has to deal and without which no science whatever can exist. A mere scholastic philosophy based upon the sterility of bare convention and authority was displaced by an honest and fearless search for the real knowledge which lies at the base of all true learning. The deadening influence of prescribed knowledge gave way to the quickening stimulus of individual power and freedom of investigation in every field of experience. All the professional schools of the university, prominent among them being the modern technical schools, are the fruitful products of this ever increasing and abundant intellectual life.

During the latter part of the eighteenth and throughout the nineteenth century the extensions of all branches of physical science so enlarged their fields of application that the foundations were laid of an-

other distinct and prominent faculty. The great investigators in chemistry, in physics, in biology and in the marvelous combinations and ramifications of those and other affiliated sciences were the pioneers in the service rendered by science to the creation of the industries of the world which have been such potent agents in the extraordinary advancement of civilization during the past one hundred and fifty years. Every addition to scientific knowledge, meaning simply a closer contact with the realities of our natural environment, has supplied a corresponding field of activity for useful effort and in just that much has enlarged the meaning and the volume of life.

All these practical or useful extensions of technical knowledge have in fact been made possible by the technical work of the university, although many of the greatest investigators and of those who have been most successful in enlarging useful production have received their individual stimulus and prosecuted their life work outside of the university organization. The university has been the nursery of useful scientific investigation and the influence of its instruction has extended with an ever-increasing acceleration far beyond the limits of its immediate environment. The practise of every technical profession is founded upon precisely that quality and kind of knowledge established by investigation and by instruction at those centers of learning which only have been the originators and transmitters of useful knowledge from the earliest beginnings of science to the present day. Although there has been much scientific investigation and remarkable applications of science to human activities by individuals or in communities, to whom apparently even the meaning of university work was unknown, the fundamental principles on which the value of the subsequent technical work is wholly based will be found in practically or absolutely all cases to have germinated in the fertile soil of the university.

The initial stages of technical education took form first in the universities of Europe. The subsequent development of that educational work into complete technical faculties is found to have been practically concurrent in the universities of both Europe and America, although the former have precedence in time over the latter by comparatively short periods. These faculties have not always been known by the names of the professional practise for which it is the purpose to prepare their students, but the apparent defect in the continuity of the case is not real. In the earliest university courses of technical study instruction was given in a substantial number of technical subjects under a faculty of broader jurisdiction than that confined to a technical profession, and in some of them that method is pursued even at the present time. Such courses of study effectually answered their purpose in the early days of the engineering and allied professions, but their administration has generally been advanced by a natural development concurrent with the growth of the professions which they have served, to remarkable groups of technical faculties of such prominence and intellectual strength and with such numbers of students as almost to dominate the true university in some cases, and even to form essentially technical universities in others.

These great technical faculties have been the direct results of the dissemination of knowledge by the university. Even the professor who has boasted that he never wittingly either learned or taught anything useful has been the servant of real learning by extending the limits of scientific knowledge which refuses to be hindered or circumscribed by its narrowest and most erratic votaries. Wherever there

has been a seat of learning, from that point has issued a quickening influence which has stimulated the growth of every form of useful activity. All the great industries on which the prosperity of every civilized nation is based, have originally sprung from the small beginnings which had their initial impulse from some branch of knowledge, acquired in the first instance at the university.

So closely are all forms of knowledge related in their fundamental elements that no one of them can attain to a state of real growth without carrying others more or less with it. This elementary principle which finds illustrations and the most conclusive proof in every field of educational experience underlies the fundamental organization of the university, and it completely justifies the place of the technical school in the university plan. Further than that, it illuminates in a clear and instructive manner the natural development of the institution of universal learning.

The ramifications of every branch of science reach a great variety of human interests many of which are directly affected by it, while others are more remotely touched. The full significance of every acquisition of knowledge can only be understood or even to a small degree appreciated by realizing the industrial activities or other real interests of the community which it affects. An isolated study of any one technical subject, or of any other subject, without regard to its relation to other branches of knowledge, would be excessively narrow in its results and probably as valueless as narrow, if indeed such a study be not unthinkable. The greater the number and scope of scientific or technical subjects brought within the range of instruction, the broader will be the whole amount of knowledge acquired, and the more complete and thorough will be the comprehension of any one of them. There is a limit to the number of subjects which can profitably be taken by any student in a course of proposed study, but there can be no question whatever that the instruction in any one subject will be enhanced in value in proportion to its breadth, or its reach into other and related or affiliated subjects.

The more complete the view of the field covered, the more satisfactory will be the student's work in it. In fact, it may be stated that the real study of any one part of the field of knowledge consists in acquiring information relating to its effect upon other fields into which it reaches. It is impossible to conceive of any subject of scientific study as an abstraction either from other subjects or from the material elements of experience.

The bearing of all these considerations on the place of the technical school in the university is most direct and essential. In the first place the instruction in any professional school of a technical character is an integral part of the whole body of instruction belonging to an institution of universal learning. It can not be given so effectively anywhere else as in the organization of which it forms a part absolutely necessary for completion.

The advantages gained by a technical school in a university environment are fundamental; they touch both its technical work and the general educational training which must precede the technical in any adequate course of study of a professional character. An engineering or other technical student pursuing his work in a university system finds himself in a stimulating atmosphere of study and investigation reaching far beyond the limits of his own field. He acquires largely by incidental or even unconscious absorption a broad cultivation by constant contact with active educational work, some of which is more or less affiliated with his and some

not. This association is an inspiration to a broader and more enthusiastic view of his own work in itself as well as a material enhancement of value of that work by disclosing its relations to other fields of learning, all impossible to attain outside of the university. These conditions give his educational training qualities that not only strengthen them and widen his subsequent professional practise but contribute most effectively to his intelligence and usefulness as an educated citizen.

More than this, the technical professions now demand of their members for the higher planes of successful practise the same general educational preparation for professional study as that required by the best law and medical schools. Without entering into a discussion as to the relative merits of the educational work done by the small college and by that forming a subordinate member of the university, it is sufficient to say that this part of a well-rounded course of professional study harmonizes completely with the university system and is in fact an essential element of it.

Both for technical efficiency, therefore, and for the broadest and best educational motives the technical school is bound to find its strongest development in an environment of universal study and investigation.

The university has long since lost the character, if it ever properly had it, of a place were abstractions of learning, separated from the things which only give them life, are to be dispensed after the manner of instruction to men who are never to deal with the affairs of life. It has come to be an intensely practical working agent. It is effective and worthy of support only in so far as it makes itself felt in the real life of the community. If it is to be a true and real center of instruction it is imperative that it shall carry knowledge into every useful calling, governmental, corporate or private. The time will soon come, if indeed it is not already reached, when it only can prepare men to administer and extend in a rational and moral way the great industrial activities which at the present time form the foundation of the material prosperity of the modern world.

The true student of the professional or technical school becomes heir to a comprehensive and clear understanding of his duties and responsibilities in his relations to his fellow men and to the community. Those duties and responsibilities present themselves to his trained mind in their real proportion. He is neither non-developed nor mal-developed in his judgment of affairs. His university training, especially in the technical school, has taught him accuracy and penetration in the analysis of any proposition confronting him, and that truth and knowledge must be sought with the directness of a plumb line. Science yields nothing but confusion to the shifty, devious and dishonest inquirer. The fundamentals of morality are the very stepping stones to technical success or professional attainment.

The opportunities offered in the administration of public affairs and the great corporate interests of the present time, rapidly increasing in number and magnitude, create almost irresistible temptations to prostitute them to selfish gain. The realization that great power, or what has now come to be its full equivalent, great wealth, is a grave and delicate trust, to which selfish gratification in its infinite and seductive variety is abhorrent, comes most naturally and easily through sound knowledge 'the beginning of wisdom.'

The correct conception of his duties gives to the professional man such a deep and true sense of his responsibilities as to render him the safest administrator of those great interests whose sinister power

has already threatened both the morals and the safety of the community. Selfish gratification is a temptation to which he may or may not yield, but his inheritance from the university translates wealth to be a means of accomplishing the highest means of life, and saves him from that narrow, common complaisancy of wealth which is the dry rot of character.

In this age of self-appointed erratic and dangerous regulators of society when an unreasoning and destructive discontent frequently prompts to crude measures whose real purpose is a blind upheaval of the existing order of things, the intelligence and the calm balance of the university man of affairs must be the corner stones of public safety. His trained mind taught to analyze and to test by the records of experience no less than by the precepts of science does not lose its poise before either the shallow plausibilities of the advocate of Utopia or the sinister deceptions of the revolutionary reformer or what has come to be nearly as bad, by the egoistic and blundering although much-applauded strenuosity of the present time. It is not to be supposed for a moment that every subject of university training will issue from its halls the ideal well-rounded citizen but judgment must be passed upon such matters in view of their resultant tendencies. A fair and careful scrutiny of the impress made through the professional schools of the university, from the older faculties of philosophy and theology to the modern faculty of engineering, upon the broad moral, governmental, professional and business affairs of the most cultivated communities of the world, conclusively confirms and supports these observations.

The creative or evolutionary influence of the university upon the community is exercised chiefly, and it will ultimately be exercised entirely, through its professional faculties, its faculty of philosophy already having become essentially a professional faculty of teaching, a character which it is bound fully to assume hereafter. This is the highest and ultimately the complete mission of the university. This means with absolute certainty that professional instruction shall be given not by closet professors, but by men who are students in the highest and best sense of the word, profound students not only of the abstract principles of their profession, but of the play and power of those principles upon the affairs of men. This knowledge must be gained by taking their full part in human experience and not by withdrawing from it. Their investigations must be made largely in the practical operations of their professions. In other words, they must be men of affairs as well as students. A living and forceful quality can be given to instruction in no other way whatever but by actual contact with the things encountered in practical experience and precisely in the relations disclosed by that experience.

Some of the professional faculties have already benefited by this quickening and energizing influence of living contact with their professions. The medical faculties are composed largely of eminent practitioners and it is not too much to say that it would be impossible to give the requisite instruction were it otherwise. It is well known that most serious defects in the present educational administration of the university faculties of law and engineering are due to the fact that too many instructors fail of that true development and broad training gained only by actual professional experience. It may be confidently stated that instruction in professional engineering subjects can not now be given with the necessary breadth and efficiency without supplementing the imperatively necessary work of the study by extended practical experience. And those ob-

servations are not peculiar to the faculties to which they are applied. The time has already come when the professional faculties, and preeminently so those of the technical schools, must be active, living parts of their professions. There is no other way by which they can either properly discharge their own functions or become members of a university organization strengthened and equipped to meet its wide educational responsibilities which make it one of the greatest conserving and elevating forces of the community.

The technical schools constituting the great modern professional schools of the university are integral parts of it and necessary consequences of its natural evolution. They belong to it historically and naturally. They are professional schools, and professional schools not only belong to the university, they are the university.

WILLIAM H. BURR.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. SECTION I—ECONOMIC AND SOCIAL SCIENCE.

THE address of the retiring vice-president, Professor Fisher, on 'Economic Science,'[1] was followed by an address of welcome by Professor Frank A. Fetter, ex-secretary of the American Economic Association, in which the work of the section was commended for its services in emphasizing the scientific method in economics in contrast with the conception which gave most attention to theoretical descipline.

The discussions of Professor Norton's paper (see below) by Dr. W. H. Welch, of Johns Hopkins, and Dr. A. C. Abbott, of the Philadelphia Board of Health, added materially to the value of this session. Dr. George W. Kober, of Washington, and Fred. L. Hoffman, of Newark, sent communications on this paper, the latter especially criticizing the proposals relating to federal control of medical institutions.

[1] See SCIENCE, August 31, 1906.

Economic Advisability of a National Department of Health: PROFESSOR J. PEASE NORTON, Yale University.

The salvation of the civilization and the race lies in the hands of exceptional men. The hope of the race inheres in their efficient organization for action. Organization consists in compelling voluntarily or involuntarily each individual to do that thing within his capability which has greatest value for society. To do otherwise is a great waste. To permit great wastes to go unchecked is more than a suicidal policy; for an evil more heinous than race suicide is race homicide.

There are four great wastes to-day, the more lamentable because they are unnecessary. They are preventable death, preventable sickness, preventable conditions of low physical and mental efficiency and preventable ignorance. The magnitude of these wastes are testified to by experts competent to judge. They play their part in a cruel devastating destruction that is almost incredible to the human mind.

The economic reasons for establishing a national department of health are five: (1) To enable society to progress more rapidly under the law of increasing returns through increasing the per cent. of exceptional men of each degree (many of whom are now lost through preventable accidents), in addition to increasing the total population. (2) To lessen the burden of the unproductive years on the productive years by increasing the average age at death. (3) To decrease the burden of death on the productive years by increasing the age at death. If the expenses of illness and death are $300 and the average age at death is forty years, the average death expenses average $15 on the twenty

productive years. Could the average age be increased to 50 years, the burden falls to $10 or a decrease of fifty per cent. For 80,000,000 of people, the saving of $1.50 per year of life would be equivalent to $120,000,000 per annum. (4) To lessen the economic burden of sickness. Assuming Newholme's figure of nine days average illness per annum, approximately 2,000,000 years of life are lost per annum. Estimating wages at $1 per day, and all other expenses $1 per day, $1,444,000,000 loss per annum is registered by this item. Could the days of illness be cut down one third nearly $500,000,000 would be saved. (5) Higgins has estimated that six hundred millions are now spent on criminality in the United States. If the criminality is largely the product of social environment, such as over-crowding, alcoholism, etc., measures which would decrease this only fractionally are worthy of consideration. A decrease of 16⅔ per cent. would result in savings of $100,000,000 per annum.

For the last four estimates, the total savings range between $1,800,000,000 and $4,000,000,000 per annum. In addition to the positive gain, in addition to the savings above, there exists a vast amount of misery and sorrow which would be lessened, but may not be measured by statistics.

How Shall the Destructive Tendencies of Modern Life be met by the Individual? Dr. Richard Cole Newton, Montclair, N. J.

First of all a physical education is needed to develop, strengthen and preserve the body. In spite of mechanical and scientific advance, we are far behind in respect to the rules of simple and healthful living. A systematic study of diet, use of narcotics, employment of exercises as they apply to 10,000 people for ten years would settle many fundamental questions which nothing short of government could successfully undertake to solve. A national bureau of health should be formed to undertake such studies and experiments as are necessary to make these inquiries. This bureau should pass on every new remedy and every proposed system of treatment, so that the humblest citizen might know that he will not injure himself in using such remedies or systems of treatment. By positive direction and training the Japanese have made their armies invincible. We must profit by their example if we would maintain our national life and our racial preeminence.

Limitation of Great Fortunes: Professor James Walter Crook, Amherst College, Mass.

The problems connected with the amassing of enormous fortunes have been given a special importance by President Roosevelt's Washington address, on April 14. The remedy by him proposed was a progressive tax so framed as to prevent giving or beqeathing fortunes, over a given amount, the tax to be imposed by the federal government.

Unlimited opportunity to accumulate fortunes has a selective value by attracting a large share of the best talent into business. A change would affect commercial activity as a pursuit. It would create a new source of federal income and greatly modify the distribution of wealth in the community.

We must remember that the wealthy in large measure manage their wealth for society. Before radical action we should consider whether the growth of large fortunes is due to temporary or permanent causes.

The causes of great fortunes are, as a rule: (1) underground resources (mining, oil, etc.), (2) development of transporta-

tion facilities, (3) combination of corporate enterprises, (4) increase in land values, (5) speculation in corporate securities, (6) monopoly. All except the second and the sixth are still open fields for the fortune maker.

Possibly something, not much, may be expected as a remedy from seeking an honorable family name, from public service, but the remedy is too remote.

Of the three methods proposed: (1) An arbitrary limit to accumulation, (2) progressive income tax, and (3) progressive inheritance tax, the first is arbitrary, the second no less acceptable, and the third is good for raising revenue but doubtful as a means of repressing accumulations.

A tax heavy enough to accomplish the purpose would raise problems of fiscal administration of a perplexing character, both in the collection and use of the funds. Economically, such a tax would repress industrial activity, financially it might cause extravagance in governmental expenditure and disturbance of the money market by its collection.

On the subject of agriculture the introductory talk of Professor L. H. Bailey, of Cornell, on the 'Problems of Agriculture,' and the paper by Professor G. N. Lauman, on 'Rural Conditions and Problems in Europe,' were timely and full of suggestion in the service of American experience.

Professor Bailey said: The farm is going to be laid out by the rural architect with regard to good taste. We shall begin with the highways and take down the advertising signs among the first. Sanitation will play a larger part. Even now many of our best dairy stables are more truly sanitary than the majority of homes in city or country. The rural home must solve its servant problem (1) by simplifying its food preparation, and (2) by reduction of labor with mechanical appliances.

Causes and Consequences of the Past Ten Years of Agricultural Prosperity in the United States: GEORGE K. HOLMES, U. S. Department of Agriculture.

The prosperity of farmers, which has been preeminently in evidence during the last half dozen years, must be and is logically reflected in the higher capitalization of their lands, and in better and additional buildings and other improvements. It has been ascertained by the U. S. Department of Agriculture that the farm real estate of the United States increased 33.5 per cent. in value during the five years following the census of 1900, or an amount that averaged $100,000,000 a month and equaled $6,000,000,000.

There has been a cessation in recent years of the longtime tendency to overproduction; there is no more cheap cultivable land of nation, state and railroad to be robbed of its fertility for cheap production. The agricultural population is becoming a smaller fraction of total inhabitants, and there is a nearer approach to equilibrium between agricultural production and consumption, helped by enormous exports of cotton, grain and meat. In the meantime, immigration, which had long poured its hordes upon the farms, has changed in character and been diverted to the cities, to consume instead of multiply the products of the farm. Besides, the consumption per capita of some things seems to have increased—of wheat, meat and its products, vegetables, fruit, poultry and eggs.

These are among the chief causes that are making agricultural consumption tend to push agricultural production, with the result that prices have risen and farming operations have become more profitable.

The greatest economic gain that the

farmer has made, apart from higher prices, is the freedom to shift from one crop to another, the most conspicuous illustration being cotton. Now that the planter is not generally working against a crop lien bearing 40 per cent. interest and profit to secure advances for living and production and has no creditor who will lend on no security but cotton, he is in a position to raise cotton or some other product, as he pleases, and there will never be an excessive crop of cotton again, unless by chance for one year, as in 1903.

Among other results of prosperity, are the ability of the farmer to borrow at a low rate of interest, his enormous accumulations, deposits in banks, and investments, the cancellation of old farm mortgages, and his ability to hold his crop after harvest until the price is satisfactory to him, in place of dumping it upon the market as he formerly did to pay debts and expenses. The farmer now has an impregnable economic position.

Economic Geography: Dr. J. Russell Smith, Wharton School, University of Pennsylvania.

Economic geography is a study of the world in which we live as a place in which to make a living. Another way of putting it is that it is the description of lands in terms of human usefulness. This phase of geography does not permit itself to be carried off into speculation of purely scientific interest unless there is also an economic aspect. It is held down by that qualification of human interest—usefulness to man.

Almost every industry and every form of human activity is controlled by the physical conditions of the land in which the people live. The understanding of these relations is economic geography, and it is one of the shortcomings of our educational system that this study has not received greater attention.

Economic geography needs to go into higher education in as thorough a way as has been the case with history. It is useful not only to other sciences but to the direct preparation of the individual for citizenship and business.

The concept and treatment of history have been rapidly changing because of the growing recognition of the part that economic conditions have had in shaping human affairs. The understanding of the past and the present are alike in their requirements. The science of economics, like history, requires for its understanding the fundamental facts of economic geography. Economic geography gives the economic facts that are requisite to an understanding of economic theory. Many of the problems of political science also grow out of geographical conditions.

Private industry and investment also depend closely upon the information given by economic geography. Twenty years ago there was a great rush of emigrants into western Kansas. They were unfamiliar with the economic geography of the region and a quarter of a million of them attempted to make farm homes where it was impossible to do so. They were driven out bankrupt after years of labor, and eastern mortgage holders also lost millions. Economic geography is quite as important to the financier as to the representative of industry or government.

On the general theme of municipal ownership four papers were presented. That by Charles W. Tooke (Syracuse, N. Y.) dealt with legal and financial phases of the problem. The discussion was opened by Charles Whitney Baker of the *Engineering News*, New York City, who said:

The 'public utilities' in cities at the present day are absolute necessities; hence

their control or operation by the public authorities is a far more vital question than it was twenty years or even ten years ago.

There have been three important changes in the public point of view of the municipal ownership question: First, the enemies as well as the friends of municipal ownership are now agreed that public utilities, if not owned by the city, must be operated under strict franchises, providing for good service and regulation of rates and limited in duration.

Second, all are agreed that 'public utilities' are natural monopolies and that attempts to create competition in the gas, water or electric supply are in the long run injurious, both to the stockholders and to the public, and hence should not be permitted.

Third, the recent disclosures of inefficiency, corruption and wholesale graft in some of the private corporations which the public has been accustomed to regard as models of good business management, has enabled people to make a fairer comparison between municipal work and private work. Public utilities in most cities are and must be operated by large corporations, unless the cities themselves take charge. In these corporations, there is and will inevitably be more or less red tape, inefficiency, graft and corruption. It probably still remains true that this corporate management will generally be more efficient than city management, but the difference is far from being as great as has usually been supposed.

Public Ownership and the Wage-Earners: H. T. NEWCOMB, Washington, D. C.

In its efforts to convert municipal, state and national governments to particular portions of its socialistic program the persistent propaganda of public ownership, whose tireless activities so visibly pervade current American politics, usually demands the support of wage-earners upon the ground that the employees of public enterprises will be more favorably treated than those of private enterprises in the same field. It is claimed that public ownership means higher wages; shorter hours of labor, and, generally, better conditions of employment.

Experience proves not only that the government is not the best employer, but that it is not even a fair employer. Nor is this all. When government engages in industry on a large scale the condition of its employees naturally and inevitably degenerates to that of slavery.

Government does not advance wages with the increased cost of living.

Democracy is an arbitrary employer. Public employees must not seek to better their condition, on penalty of discharge, according to President Roosevelt's order of January 31, 1902.

Compulsory labor in New Zealand (Parsons, 'Story of New Zealand,' p. 179 seq.) gives no hope to labor for freedom under government employment.

The public employer has neither the knowledge of labor conditions, nor the incentive to efficiency which springs from the demand for pecuniary success. As truly as republics are ungrateful, the majority is sure to prove harsh as a task-master, and grudging in yielding compensation to its servants. Its enthusiasms are usually, not always, toward generosity, but they are changing, remittent and unreliable, while its sterner morality produces an ideal of justice that inspires the niggardly legislator while he crushes, in the ostensible interest of the taxpayer, every proposal to deal fairly and, therefore, wisely with the problems arising out of the public employment of labor. More than this; democracy, or the majority, through which it operates, is intolerant of disagreement with its principles, relentless in beating down opposition to its policies, merciless to the minority

which persists in impeding the execution of its will. What could such an employer be, in dealing with labor on a large scale, save a harsh task-master? What could it naturally become save a driver of shackled slaves? Where is the clear-headed and independent wage-earner who will consciously invoke such tyranny?

Fallacies of Municipal Ownership: Allen Ripley Foote, Secretary State Chamber of Commerce, Columbus, Ohio.

The most beneficent service a government can render the people is to correctly regulate, not to own and operate, public service utilities. Every gain made in reducing prices for services charged to the people by eliminating the political elements of the costs of ownership and operation paid by corporations, can be eliminated by placing corporations under a correct system of regulation, and granting them, without charge, every privilege enjoyed, without payment, by the municipal corporation.

Politicians now take advantage of corporate mistakes to make promises of better service. They make a show of keeping their promises to the people, by the simple process of not charging into the account numerous items all of which are paid by corporations and must be covered by prices they charge for services rendered. The apparent gains sometimes shown by municipal ownership advocates in the department of economic costs, on close analysis and inspection are invariably found to be the products of political book-keeping, and an unsound financial policy. These include the payment of the interest account on bonds out of the tax-payers' money and charged to general expense, instead of to the operating expenses of the utility; no insurance, with losses by fire to be paid out similarly; no account taken of depreciation.

Economic gains are thus shown, but not made. Such gains must be earned, they can not be created by a fiat resolution. Instead of making savings for the people, municipal ownership has resulted in hampering, restricting and deadening all enterprise and improvement in the industries it has absorbed, and in placing heavy burdens upon the tax-payers.

Correct regulation would require all corporation accounts to be kept in the form prescribed by the state for the information of the people. There would be an end of watered stock; wars between competing corporations would cease; operating costs would not be inflated by charges for franchises and property taxes; prices charged for services would be true economic prices.

The Corporate and the Individual Conscience: Cora Agnes Benneson, LL.B., Cambridge, Mass.

Within the last decade great changes have taken place in business management. From individuals it has passed to corporations, composed of individuals, to be sure, but they must now consider corporate instead of personal interests; they have, or should have, a corporate conscience.

Granted, that although a corporation proverbially has no soul, it has a corporate conscience. Who is responsible for that conscience, the stockholders, the directors or the state?

On measures involving public welfare, the state conscience should be on the alert. If a corporation corners a necessary commodity, like wheat or coal, or unduly cheapens labor, it is dangerous to the republic and the state should take away its charter. State laws should be passed protecting minority stockholders.

The directors are responsible for the corporate conscience, when they resort to double-dealing, as for instance privately giving lower railroad rates to certain corporations than to individuals, or exploiting the corporation for private ends. The

remedy lies with the stockholders to put such out of office. Stockholders are responsible for the corporate conscience when they permit corporate measures they would not personally sanction.

Few stockholders attend annual meetings. If they absent themselves, what right have they to complain that the directors are self-elected and a small number or even one gains control? Attendance gives opportunity to ask questions; the more searching these are, the more welcome are they to directors who have nothing to conceal and who have kept the corporate conscience clean.

The Public Bath System of Brooklyn: WILLIAM H. HALE, Brooklyn, N. Y.

A system of free public baths is a most important and beneficent exercise of municipal ownership, conducing as it does to public health and ultimately to improvement of public morals.

The floating baths have long been in use along the river front during the summer season; three of these dating back nearly or quite thirty years are still in commission; two more were built in 1897, and the five are now open to the public. It is estimated that 1,500,000 people used these baths last summer.

The system of interior baths open the year around is very recent. Six have been opened thus far.

These baths provide shower baths, with hot and cold water, free to all. Soap is provided at a cent a cake and use of towels for a cent. Tubs in private rooms with soap and use of towel, cost five cents.

Great care is taken to keep the bath houses well cleaned, and this is so well done that many of our good citizens use the public baths, and many persons regularly come from New York to use them.

Receipts for soap, use of towels and use of tubs in 1905 were $4,446.75. The estimated attendance during 1905 was 6,000 a day.

The cost per capita of each bath for the Montrose Avenue bath for April, 1906, was 3.42 cents. The number of bathers for this month was reported as 47,956, and the cost of operation of that bath above receipts for that month was estimated at $1,594.01. This does not include the cost of the water used nor any estimate to cover rent for the building, but merely operating expenses.

And it is indeed doubtful whether public funds can in any way be better expended than in the cleansing of the people by these baths, in promoting health and comfort, and in its generally ameliorating effect. It is the testimony of the attendant in charge of the bath which we have just been discussing that it has a distinctly perceptible effect not only in improving the health, but also in elevating the moral tone of the community in that immediate neighborhood.

Regulation of Freight Rates: N. T. BACON, Peace Dale, R. I.

The railroads legitimately object to freight charges based on mileage only, that in many cases, and especially for short distances, haulage only represents a minor part of the cost to them, being of less importance than switching, and the use of terminals and rolling stock. To meet these objections rates are proposed based on three subdivisions of the charge:

1. Terminal charges for switching and use of terminal facilities. For this all stations should be graded, according to annual freight receipts, into say six classes, terminal charges to be uniform for each grade of stations for the different services rendered at each end.

2. Use of rolling stock.

3. Haulage.

All these should differ for the different classes of freight, but all rates and gradings should be published, and no modification

allowed without publication a month in advance. Charges should be only for services rendered, so that in case of concerns owning their own sidings and doing their own switching, terminal charges would be eliminated for that terminal, but not at the other unless the freight received such treatment at both ends. Similarly no charges should be made for rolling stock against firms providing their own cars, except that where they are returned empty a suitable published rate should be made for this. These are the legitimate advantages of wealth, but no illegitimate advantages such as exclusive contracts should be tolerated. Those already existing are probably ultra vires for common carriers and therefore void.

Freight classification should be left to periodical conventions of general freight agents. It is too complicated for any other treatment.

Finally, the railroads should be liable for demurrage for unreasonable delays, on a basis similar to that on which they charge demurrage for delay in unloading. Some allowance should be made for extraordinary demands; but favoritism should be drastically punishable, and the president or directors of a railroad should be personally responsible for the shortcomings of subordinates, without exonerating these. Moreover, those finally responsible should be under heavy bonds and not at liberty to avoid suit by taking refuge abroad. Our laws should be altered, to allow an action *in rem* instead of *in personam* in the case of any fugitive from justice who does not return on publication of a summons. There are few greater scandals than those of wealthy men abroad defying our laws while they depend on them for the enjoyment of the income of their property.

The Problem of Railroad Taxation: Herbert N. Edwards, Yale University.

The modern industrial corporation has found its chief field of operation in transportation which is the life of industrial development. In the United States methods of assessment and collection of taxes on these properties are so varied as to be confusing. But in principle there is more uniformity. Forty-seven out of fifty states and territories tax their railroads on the basis of physical valuation. The general property tax still obtains nearly everywhere, but by methods differing from that used in taxing individual property. The method in most common use is the state board of assessment and collection. The average value per mile is the valuation basis to which any given rate is applied. But valuation is in some cases not that of use and personal property but of the stocks and bonds (Delaware, Pennsylvania, Massachusetts, New York) supplemented by gross receipts tax.

Railway taxes are now the chief source of state revenue in many cases, leaving the general property tax to local divisions. In Michigan the basis is the sum of values of the tangible and intangible property. Plehn advocates the value of their securities as the best basis and Seligman the taxation of net receipts. The states now derive $60,000,000 revenue from this source. Their methods are, however, inadequate and some form of federal control is needed for the sake of more harmonious methods.

What may Accounting teach Economics: Frederick A. Cleveland, New York.

To the economic dogmatist and abstract reasoner who conceives economics as composed of a set of specific doctrines as expounded by the physiocrats, the Malthusians or the Marxians, or as embraced in a congeries of concepts known as the abstinence theory of capital, the marginal theory of rent, the residual theory of labor, the quantity theory of money and the utility

theory of value—to these accounting can teach nothing.

On this conception of economics, after a century of research and discussion, Professor Hollander holds that we have not as yet developed any scientific conception of industrial society. Many others agree with him. Economics as a branch of science is rather concerned with *the group activities of man toward individual and social gain.* The point of view is that (1) of economic factors, (2) of economic relations (*a*) to the material world and (*b*) to institutions both social and economic, and (3) the forms of economic income, including private and public incomes.

Already considerable progress has been made in this direction by others than economists, especially by the student of history and public law. Scientific economics considers data as related to (1) organization, (2) problems of administration, and (3) methods and technique. We must lay aside dogma and classify data to get an intelligent grasp of affairs.

Accountancy is to scientific economics what the clinic is to medicine. The examination made by the professional accountant is for purposes of prescription. A record of the diagnosis, of the prescription, of the remedial result, and of the history of the performance of normal physiological functions recorded in the accounts, may be taken as the data upon which broad scientific generalization may be based; this broad generalization should be made by the economist.

Structure of Cities: RICHARD M. HURD, President, Lawyers' Mortgage Company, New York.

Cities grow and conform to economic law. The point of origin is that of contact with the outer world. In its organization from 40 to 70 per cent. of the area is used for streets, the balance is devoted to three uses: Business, residences and public buildings. The distribution of business utilities is purely economic, land going to the highest bidder. Residence areas are based on social considerations. Growth is axial or central—around centers or around the circumference.

Central growth has two main aspects; first general growth in all directions from the point of origin and second local growth around subcenters within the city, such as transportation termini, public buildings, exchanges, factories and hotels. As a city grows the centralizing influence of public buildings steadily diminishes while its exchanges assume increasing importance, these varying in character according to the leading business transacted in the city. Normal growth consists of the gradual aggregation of buildings of the same character due to the gregariousness of mankind and the saving in time from the close juxtaposition of buildings. Continuity is a vital feature of all growth, whether central or axial, every break causing a weakness in the structure similar to the loss of a link in a chain. An internal movement which constantly goes on is the gathering together of similar forms of business into special districts.

There are three main causes of changes in a city's structure; increase of population, increase of wealth and new transportation facilities. Increase of population without increase of wealth would normally tend only to a gradual extension of buildings of the existing character over a larger area. Increase of wealth, however, causes continual rebuilding within the city, old-fashioned shops, dingy offices and plain residences being supplanted by buildings of a new standard of magnificence. New and improved methods of transportation draw residences beyond the city's limits, concentrate business in higher buildings at the center and establish new axes of travel as

additional vertebræ for the city. More and more in the life of great cities is improved transit of importance, the tendency being for traffic to mass at intersecting points with inferior utilities in the quiet side streets.

Insurance Problems relating especially to the Management of Assets and Legal Regulation of Investments: Dr. Lester W. Zartman, Yale University. (To be published elsewhere.)

The New York insurance investigation revealed the dangers and abuses in the management of insurance assets. As a result stricter legal regulation has become necessary. The evils of insurance fund management are of three classes: (1) Officers and trustees made personal profit out of the company's funds; or (2) they took no interest in the disposition of the funds, and (3) the policy-holders to whom the funds belong exercised no control over their property.

Stricter limitation of the investing powers of officers and trustees has not proved an adequate reform. It has rather produced abuses, such as collateral loans and trust company deposits, both of which should be given up.

The vulnerable point in insurance is the making of personal profits by officers and trustees. Making this a penal offence would tend to divorce insurance management from other lines of business. Stock insurance companies should be forbidden, because of the danger of stock control, and real mutuality secured. Abolish the proxy system and provide voting of policy-holders by mail for boards of managers are in the right direction. More reliance should be placed on the election of responsible directors than in strict legal regulation.

Mathematics and Formal Discipline: Joseph V. Collins, State Normal School, Stevens Point, Wis.

In the training of the reasoning powers the service of that faculty in social and economic science is to be considered. Professor Lewis (Dartmouth) in his study of formal discipline by tests in geometry and practical reasoning (*School Review*, April, 1905) shows that a relationship exists but does not prove the faculty theory true. Tables prepared by the author of the present paper show that what a student does in any subject depends more on his mental equipment and native environment than on the particular matter considered.

Mathematics gives a training *sui generis*. In arithmetic the problems correlate at many points with the actual affairs of life. Speaking broadly, though the most important effects of the mathematical training are abilities of quite general application: as, holding a number of particulars in the mind at one time, training in sustained reasoning, habit of overcoming difficulties, recognizing the universality of the application of correctly stated laws, perceiving the need of care to secure the accuracy of results required, and so on. These powers have identity of qualities with multitudes of activities the individual finds himself engaged in in after life. They thus furnish hooks on which to hang new experiences and conquer new problems. In these ways perhaps more than in any others mathematics justifies its place in the course.

The following papers were read by title or in abstract:

Conditions and Needs of Southern Agriculture: Professor Andrew M. Soule, Blacksburg, Va.

Labor Conditions in Southern Farming: Professor F. W. Massey, Raleigh, N. C.

Value of an Organized Working Force in Industry: President E. L. Blackshear, Prairie View, Texas.

Restriction of Telegraph Development Under Monopoly Control: ROMYN HITCHCOCK, New York.

J. FRANKLIN CROWELL,
Secretary.

SCIENTIFIC BOOKS.

The Vegetation of the Lamao Forest Reserve. By H. N. WHITFORD. *The Philippine Journal of Science,* Vol. I., No. 4, pp. 373–432, pls. 1–27, with map; May, 1906; and Vol. I., No. 6, pp. 637–682, pls. 28–45; July, 1906.

This paper embodies a careful descriptive account of a large body of virgin forest near Manila, in the study of which the author has carried into the tropics the precise methods of temperate forestry and the viewpoint of physiographic ecology as developed by Cowles. The Lamao Reserve occupies an area of 4,426 hectares on the eastern slopes of Mount Mariveles, which is located in the center of the peninsula which forms the northern mouth of Manila Bay. The reserve runs from sea-level up to 1,406 meters altitude and presents throughout an erosion topography. The climate of the region is shown to possess a marked dry season from December to April, with copious rains in the remaining months; the annual curve of humidity follows that of rainfall and the temperature is rather constant with an annual mean of 36° C. and an annual mean range of 3.4° C.

The forest is midway in character between the evergreen hygrophilous forest and the monsoon forest, differing from each in having an intermingling of evergreen and deciduous trees. The author distinguishes six types of forest formation in his area with distinctions due to differences of altitude and the attendant change in climatic conditions: (1) The Strand, which is found to agree closely with that described by Schimper for the Indo-Malay Peninsula. (2) The Bambusa-Parkia formation, characterized by an open stand of trees many of which are leafless throughout the dry season, and by pure and mixed growths of several species of bamboo, which are in effect partly deciduous. (3) The Anisoptera-Strombosia formation inclines less to the monsoon type, as it contains no trees which are leafless throughout the dry season; bamboos are here replaced by small dicotyledonous trees; the specific make-up of the forest is very complex. (4) The Dipterocarpus-Shorea formation exhibits an almost complete absence of deciduous trees and a simpler floristic make-up than the formations at lower altitude. Here the variations due to differing physiographic situation begin to be manifest. (5) The Shorea-Plectronia formation lies between 400 and 900 meters altitude and has a more hygrophilous climate than the last formation with a more abundant representation of pteridophytes and bryophytes. The instability of the substratum in this formation and the next prevents as rich a development of the forest as the climate would lead one to expect. (6) The Eugenia-Vaccinium formation lies above 900 meters altitude and is characterized by a very humid and cloudy climate together with high winds. The forest is here xerophilous and stunted on the ridges, although more hygrophilous in the ravines and depressions. Epiphytic vegetation abounds and liverworts and filmy ferns are common. Many genera are represented in this formation which are common to tropical mountains throughout the world or even to the temperate regions.

In the Bambusia-Parkia formation a study has been made of the clearings, known as 'parangs,' and the return of these areas to the climax forest. Some six types of parangs are characterized, in each of which the flora is poorer than in the original forest, and may consist largely of comparatively pure stands of certain small trees or may be occupied by the climbing bamboo *Dinochloa.* In each of the formations a detailed enumeration of the forest trees has been made in several plots on different soils or in different physiographic situations. The summation of results for six plots in the Anisoptera-Strombosia formation, aggregating 5,850 square meters in area, shows a total flora of 99 species. Of these the five most abundant form but 35 per cent. of the total and 64 are represented by three individuals or less. In another series of seven

plots in the same formation 120 species were found of which the five commonest form 30 per cent., and 91 form each less than 1 per cent. Quite as striking as the wealth in species and the poverty in individuals is the variation between the different plots in the same formation.

Note has been taken of the lianes, epiphytes and herbaceous vegetation, and many valuable observations made on the foliage, bark, latex, buttresses and cauliflory of the trees. It is unfortunate that more attention could not have been given to the herbaceous vegetation.

The paper as a whole, with its abundant illustrations, gives a vivid picture of the vegetation of a region not before well known to us. Manifest importance attaches to the carrying into the tropics of the detailed and comprehensive methods of studying vegetation which have been in use in the temperate regions. The fact that our methods and our points of view are both the products of the study of temperate vegetation must compel care in the application of these in the tropics. While the method of the study of plots gives interesting results as to the wealth and composition of a tropical forest when first applied in a particular region, yet it does not give facts of the same order as those ascertained by the study of plots in the temperate zone, as may be seen by a comparison of the lists for plots in the same formations in the Lamao reserve. The reviewer doubts if the term 'climax forest' is one that would have come into existence if the first students of physiological plant-geography had resided and worked in the tropics. The term is certainly an extremely elastic one as used by Dr. Whitford.

It is greatly to be hoped that we may have in the near future further papers of this nature from members of the botanical and forestry staffs of the Philippines.

Forrest Shreve.
The Woman's College, Baltimore.

SCIENTIFIC JOURNALS AND ARTICLES.

Bird-Lore for September-October contains a well-illustrated article on 'The Home Life of the Red-tailed Hawk,' by Robert W. Hegner; an account of 'The Nesting of the Arctic Three-toed Woodpecker in the Adirondacks,' by Lawrence Achilles; an article on 'The Rose-breasted Grosbeak,' by Frederick L. Holtz, and one on 'The Habits of the Black Vulture,' by A. A. Saunders. W. W. Cooke contributes the eighteenth paper on 'The Migration of Warblers.' In notes and news are the records of two plume sales in London, footing up over 35,000 birds, including 19,000 birds-of-paradise. The Audubon leaflet is devoted to the blue jay.

The Zoological Society Bulletin for October has an article, with a good illustration, on the African pigmy Ota Benga, and there are good papers on 'The Collection of Reptiles,' 'How Seals are Trained,' 'The White Peacock' and 'How Birds get Their Food.' The capture of two tarpon in New York Bay is recorded and there is a description of a new sea-horse from Bermuda to which the name *Hippocampus kincaidi* is given. Judging from the figure, it should belong in another genus. There is probably a slip of the pen in the statement under the cut of 'One of the Largest of Our Tortoises' that 'The growth of this specimen has been so great as to oppose the theory of the great age which these reptiles are supposed to attain.' What is doubtless meant is that great size does not necessarily mean great age, for these tortoises have been known to live over one hundred years.

The Museum News of the Brooklyn Institute Museums for October begins its second volume with a brief summary of the summer's work. In the section devoted to the Children's Museum is a good account of Tadourac and the Saguenay River, in which the occurrence of the killer, *Orca*, is noted. The museum has a living specimen of *Hyla andersoni*.

SOCIETIES AND ACADEMIES.

THE ST. LOUIS CHEMICAL SOCIETY.

The first meeting after the summer recess of the St. Louis Chemical Society, was held on Monday, October 8. A report 'On the National Pure Food and Drug Law, and On the Recent Hearing by the Official Commis-

sion in New York City,' by Dr. C. E. Caspari, attracted a very full attendance of members and invited guests. Dr. Caspari had attended the sessions of the commission as a representative of two firms of New York City, hence his communication had all the interest of personal knowledge. A rather lively and prolonged discussion of the subject from the chemical and pharmaceutical point of view manifested the interest of the members in subject matter of the law and the law itself.

C. J. BORGMEYER,
Corresponding Secretary.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY OF THE UNIVERSITY OF NORTH CAROLINA.

THE 167th meeting of the Elisha Mitchell Scientific Society was held in the main lecture hall of the new Chemical Laboratory on Tuesday evening, October 9, at 7:30 o'clock. The following papers were presented:

PROFESSOR COLLIER COBB: 'Geology and Forestry in the Ducktown Region.'

MR. HAMPDEN HILL: 'Deforesting of the Ducktown Region by Sulphur Fumes.'

PROFESSOR CHAS. H. HERTY: 'The Electric Smelting of Iron Ores.'

DISCUSSION AND CORRESPONDENCE.

'AN IGNORED THEORY OF THE ICE AGE.'

IN SCIENCE (October 5, page 439) there is a communication from Dr. J. M. Schaeberle, under the above title, of which the following is the opening paragraph:

> Looking over the recently issued work on 'Geology,' by Professors Chamberlin and Salisbury, I was surprised and disappointed to learn that in this voluminous publication of nearly two thousand pages, many of which are devoted to considerations of causes leading up to the ice age, the name of Dr. Marsden Manson is not to be found.

We, in our turn, are surprised that before going into print with this statement, Dr. Schaeberle did not consult the index of the work in question, where, in its appropriate place, he might have found:

> Manson, M., cited, iii, 445.

Referring to the page named, he would have found a section devoted to the cloud hypothesis and the wind hypothesis. Under the cloud hypothesis the following references are given:

> Manson, *Am. Geol.*, Vol. XIV., 1894, pp. 192–194; Vol. XXIII., 1899, pp. 44–57; and Vol. XXIV., 1899, pp. 93–120, 157–180, 205–209.

The discussion was, to be sure, generic rather than specific, and was directed toward the evolution of hypotheses concordant with the present state of discovery and inquiry, rather than retrospective. It was no part of the policy of the authors in preparing the work to bring up the specific views of an individual writer only to throw them down, unless wide acceptance required their consideration. Especially did the authors endeavor to avoid the adverse criticism of individual views when the ground had been adequately covered already by generic treatment. They, therefore, saw no sufficient reason for reciting and criticizing the special view of Dr. Manson that the earth, from the Archean to the Middle Tertiary, was shrouded in a mantle of clouds so deep, dense, universal and persistent that the sun had no effective differential influence on the temperature at the earth's surface, which was maintained by internal heat, and his conclusion that the Pleistocene glaciation was an incident of the transition from this cloud-shrouded era to the present one and was hence the only true glacial period. The authors had recited with care the evidence that there were other and much earlier glaciations whose extent and character raised even more exacting climatological questions than the Pleistocene glaciation. They had cited, in their appropriate places, the paleobotanical evidences of open and varied skies and diversities of atmosphere, specifically noting that the upper sides of leaves of different genera even in Paleozoic times were provided with palisade cells as a protection against too great intensity of sunlight. They had discussed at length and repeatedly, in the proper places, the great evaporation deposits and their associates, together with the related evidences, both physical and organic, of wide-spread and recurrent aridity, with its obvious implication of open and diversified skies and of effective solar action. It had been specifically pointed out

that in the elucidation of the Permian climatological problems which have now become the climacteric ones, no appeal could be taken to a supposed final refrigeration, or to any declining stage or senile condition of the earth, and that hence all hypotheses which involve such features had been set aside by the advance of discovery. There appeared, therefore, no good reason for calling up specifically Manson's theory merely to say that it had been put out of court by the progress of geological inquiry, especially as the recital of the results of inquiry, and their necessary implications, had already told the tale for themselves.

T. C. Chamberlin.

University of Chicago,
October 8, 1906.

Correspondence relating to the survey of the coal fields of Arkansas.

To the Editor of Science: I enclose herewith copies of the correspondence between the Director of the U. S. Geological Survey and myself regarding a matter of far-reaching importance to the geologists and other scientific men of this country.

A word is necessary by way of introduction: I was state geologist of the state of Arkansas from 1887 to 1893. One of the first things undertaken by the survey under my direction was a report upon the coal fields of that state. The work was under the immediate direction of Arthur Winslow, a graduate of the Massachusetts Institute of Technology, for some years assistant of the Pennsylvania survey in the anthracite regions and later for several years state geologist of Missouri. Mr. Winslow was assisted by several competent men, among whom were Professor Gilbert D. Harris, now state geologist of Louisiana; Dr. C. E. Siebenthal, now assistant on the U. S. Geological Survey; H. E. Williams, until lately chief topographer of the S. Paulo Geological Survey in Brazil; J. H. Means, consulting geologist, London, England; and Dr. J. F. Newsom, now professor of economic geology in Stanford University. In 1888 a preliminary report on the coal was published, but the final report was completed later. Owing partly to interruptions and delays that are here irrelevant and partly to lack of funds for the purpose, the final report on coal was not published up to the time I left Arkansas. Efforts were made from time to time to have the legislature provide for its publication, but it was never printed, in spite of the fact that it was economically the most important piece of work the state survey had done. Finally, in 1902, I suggested that the U. S. Geological Survey publish the report, and this was agreed to on condition that the maps of the coal region be reduced to a scale of two miles to the inch and that the contour interval be changed from twenty feet to fifty feet. To this I would not consent because the matter was one of too much importance to the people of Arkansas. Thereupon negotiations came to an end. Later I called the attention of U. S. Senator James P. Clarke, of Arkansas, to the importance of having this coal report brought up to date and published on a scale of a mile to the inch. Shortly afterwards I received the following letter from the director of the U. S. Geological Survey. The rest of the correspondence is self explanatory.

J. C. Branner.

U. S. Geological Survey.
Washington, D. C., Jan. 31, 1906.

Dr. John C. Branner,
Stanford University, Cal.

Dear Sir: There have recently been made several urgent requests by parties interested in the Arkansas coal field for a geological resurvey of that region. The persons making the request claim that since your survey of the field old workings have been extended, many new mines have been opened, and the region has been thoroughly prospected with the diamond drill. This development work has given more definite limits to the workable coals in areas heretofore mapped as coal-bearing, and has shown that workable beds occur in areas not hitherto recognized as containing coal. It is further urged that the coal of this region is becoming of such commercial importance that the United States Geological Survey should enter the field, assemble the data at hand, and make a very thorough and detailed survey of the region.

In view of the above conditions it seems desirable to take up this work in the near future.

Before doing so, however, I wish to lay the plans before you and ascertain if it is not possible to make some arrangement whereby the work done by you as state geologist of Arkansas can be utilized.

As a basis for practical cooperation the following plan is suggested,

1. That all notes and maps in your possession pertaining to the Arkansas coal field be turned over to this Survey for use in the proposed investigation;

2. That this material be used by the geologic parties so far as practicable in making a careful resurvey of the field, special attention being given to the economic features, and

3. That the results of this work be published by the United States Geological Survey in such form as may be decided upon, with the geology either shown upon the topographic base, upon the scale of 1:62500 as at present engraved, or on some reduced scale.

It will be understood that in all reports dealing with this region full credit shall be given to you and to the Arkansas Survey for the geologic material furnished by you and used in the resurvey, as well as for the topographic base maps prepared by this Survey under a plan of cooperation adopted in 1890.

Should this plan meet with your approval, kindly let me know at your earliest convenience, as preparations are being made for beginning field work in the early spring.

Very respectfully,

CHAS. D. WALCOTT,
Director.

(Sub-signature C. W. H.)

STANFORD UNIVERSITY, CAL.,
February 9, 1906.

HON. CHAS. D. WALCOTT,
Director of the U. S. Geological Survey.

Dear Sir: I have your letter of January 31 (C. W. H., M. R. C.) regarding a resurvey of the Arkansas coal fields. It goes without saying that I shall be glad to cooperate with the survey in this matter.

Having planned, directed and done a large part of the work in the coal regions of Arkansas, having carefully preserved and guarded the results of the survey since it was suspended, and having made several later trips to different parts of that region, I am naturally deeply interested in its geology and in the publication of the report.

After having done so much work upon it I feel that, by some sort of equity, I ought to be allowed to finish it. For that reason I venture to suggest that the U. S. Geological Survey allot what you consider a reasonable sum for the completion of the work under contract with me. Such an arrangement would make it possible to finish the field work during the coming summer and to submit the completed report about March or April, 1907.

About two thousand five hundred square miles of geology should be gone over, and all openings made since 1889 should be examined, statistics gathered, and maps corrected to date.

As to the cost I suggest that the assistants whose judgment you rely upon in such matters be asked to make a just estimate of the probable cost of the work if done by some equally competent person with details warranting the publication of the maps on a scale of an inch to the mile, and that the amount so agreed upon be the price for which I should do the work. It should furthermore be understood that this price is to cover all expenses of field-work, supervision, preparation of the manuscript report, drawings, maps sections, photographs, etc., up to the submission of the report to the editor, and that the survey is to be called upon only for the necessary copies of the topographic maps now in its possession and for such analyses and coking and fuel value tests as may be necessary for the work.

Yours respectfully,

J. C. BRANNER.

U. S. GEOLOGICAL SURVEY.
WASHINGTON, D. C., Feb. 16, 1906.

DR. JOHN C. BRANNER,
Stanford University, Cal.

Sir: The plan of cooperation for the survey of the Arkansas coal field, which you propose in your favor of February 9, in answer to my letter of January 31, seems to differ in no essential particular from those that have been considered in the past and that have not proved acceptable to this bureau.

We have here a large force of men who have had wide experience for the last 10 or 15 years in coal work in various parts of the country, and also in connection with the Coal-Testing Plant at St. Louis, and we would not care to consider any proposition which would take the survey of the Arkansas coal field out of the control of these men.

The demands for a resurvey are so great that we feel compelled to enter the field, and, while the work done by you a number of years ago would doubtless be of some assistance to us, practically we expect to resurvey the entire region as though no previous surveys had been made. As

stated before, the only form of cooperation that is at all practicable is that proposed in my letter of January 31. This seems to be reasonable and just, and will give you full credit for all of the work that you have done, and for the maps of the region which you have prepared. Should you not be willing to accept this proposition, your material will be of little value, and there will be no hope of future publication.

We propose to send a party into the field on or about March 1, and if you feel inclined to accept our proposition, we shall be glad to hear from you at your earliest convenience so that the party may have the benefit of your material.

Very respectfully,

CHAS. D. WALCOTT,
Director.

(Sub-signatures M. R. C. and C. W. H.)

STANFORD UNIVERSITY, CAL.,
February 26, 1906.

HON. C. D. WALCOTT,
Director of the U. S. Geological Survey,
Washington, D. C.

Sir: I beg to resign my position as geologist of the United States Geological Survey.

The immediate reason for my resignation is that I consider the action of the survey as communicated in your letter of the sixteenth in regard to my work upon the coal regions of Arkansas as an outrage and an unwarranted personal affront to which no self-respecting geologist can tamely submit.

Respectfully yours,

J. C. BRANNER.

WASHINGTON, D. C., March 8, 1906.

DR. J. C. BRANNER,
Stanford University, Cal.

Dear Sir: Your letter of February 26, containing your resignation from the survey, is received. I sincerely regret that you have felt impelled to take this action. Certainly no outrage or affront was intended in my letter and I fail to understand the reasons for your position.

The field work of the Arkansas Survey in the coal districts was done, as I understand, about eighteen years ago. It was based upon topographic maps which are much below the present standard and which could not be published on the present scale without thorough revision, amounting in most cases practically to a complete resurvey.

It is no reflection upon that work or the geologists who were responsible for it to say that it does not come up to present standards, and, therefore, could not be accepted for publication by this survey. Moreover, the active development since the state survey work was done now makes a large amount of information available which was quite inaccessible in 1888, and any publication by this survey would be judged by present standards and in view of this new information. We have refrained from entering this field notwithstanding many urgent requests, in consideration of the fact that your final report remained unpublished. It now seems necessary to meet the demands for information which have become especially insistent since the results of the fuel-testing work at St. Louis have indicated new and important uses for this coal. Also several serious complaints have been made of specific errors in the map of the Arkansas coal fields published in the Twenty-second Annual, by which considerable losses have been occasioned.

A resurvey of the region being therefore necessary, it seemed to me that the work should be done by members of the regular survey force, from whom immediate results could be obtained and whose salaries must in any case be provided for. I was anxious to obtain your unpublished data, for which adequate payment would have been made and full credit given, both as a matter of justice to yourself and to avoid the duplication of so much of the work as could be utilized. I still think this is by far the best way in which this unpublished material can be utilized, but shall not urge your acceptance of the offer.

I shall hold your resignation for the present with the hope that you may be willing to reconsider the matter.

Very respectfully,

CHAS. D. WALCOTT,
Director.

(Sub-signature C. W. H.)

STANFORD UNIVERSITY, CAL.,
October 13, 1906.

HON. CHAS. D. WALCOTT,
Director of the U. S. Geological Survey,
Washington, D. C.

Sir: Your reply of March 8, last, to my proffered resignation was duly received. I have postponed answering your letter in the hope that time might enable me to see the wisdom and justice of your decision, and to feel less acutely the personal reflection upon myself and upon my assistants implied by the survey's action. Seven months have now passed since I received your letter of February 16, telling me that you would not consider any proposition that would leave me to finish my own work, and reminding me that

unless I turned over the data collected by me and by my assistants my 'material will be of little value, and there will be no hope of future publication.' In the meanwhile I have made every reasonable effort to get your point of view, to put myself in your place, and to find some excuse for a course of action on the part of the U. S. Geological Survey that, on the face of it, seems so unjust, especially as it discredits me not only in the eyes of my colleagues but in the estimation of the people of the state of Arkansas whom I have faithfully tried to serve.

To my great regret not only am I unable to find any just reason for your action in this case, but the more I have informed myself regarding the attitude of the survey toward individual workers in geology throughout the country the more have I been convinced that I can not remain a member of that organization.

Justice to myself requires that I say a word regarding the reasons for your course put forward in your letter of March 8. These reasons appear to be:

1. The field-work on the Arkansas coal region was done eighteen years ago.

2. It was based upon poor maps.

3. The work is not 'up to present standards,' and therefore could not be accepted for publication by the survey.

4. New uses for the coals have been found by the fuel-testing plant of the survey.

5. Losses have been caused by errors in a map of the Arkansas coal fields for which I am responsible.

6. The salaries of the regular assistants of the survey being provided for work must be given them.

7. You say: 'I was anxious to obtain your unpublished data, for which adequate payment would have been made and full credit given.'

Inasmuch as these are put forward as the real reasons for the survey's action in this case I beg to call to your attention the following facts:

1. It is fully recognized that the work was done so long ago that it needed to be brought up to date. Many new mines have been opened and much information is now available that was not available when the original work was done. But having originated and directed the survey of the Arkansas coal fields I hold that *it was altogether reasonable that I should be allowed to bring the report up to date, and if it needed correcting that I should be permitted to correct it.*

2. As for poor maps let me remind you that when my work was begun in the Arkansas coal fields the maps of that region made by the U. S. Geological Survey were so poor that they were absolutely useless. The topography was shown with contour intervals of fifty feet, an interval so large that the characteristic features of the country were lost sight of, the land lines were not put on them at all, and the work had all the ear-marks of haste and indifference to the needs of the people. I was, therefore, obliged to remap the region on a scale of a mile to the inch with twenty-foot contour intervals. The maps made under my direction were based upon the land-office plats, and were necessarily cheap maps. But they were so much better than those made by the U. S. Geological Survey that the survey engraved them for me, and owns the original plates. If you have any doubt about the truth of these statements you only need compare the Fort Smith sheet of the U. S. Survey made in 1887 with the sheets of the same region made afterwards under my direction and engraved by the U. S. Survey. Under the circumstances reference to poor maps comes with bad grace from the director of the U. S. Geological Survey. The main weakness of the poor map excuse, however, is that nothing was said in our correspondence regarding topographic work. It was taken for granted that *if the topography needed revision it could be revised for me as well as for some one else.*

3. One would suppose that the statement that the work is not up to present standards was based upon some sort of knowledge of the report. As a matter of fact neither you nor any of your assistants have read the report, and you can not, therefore, know anything about its relation to standards of any kind. Moreover, even without reading it, *the U. S. Geological Survey offered to publish this same report in January, 1902,* on condition that I should consent to the publication of the maps on a scale so small as to make them useless to the people of Arkansas. One might suppose that it was up to standard in 1902 but had degenerated by 1906.

4. Referring to the new uses found for Arkansas coals by the fuel testing laboratory of the U. S. Geological Survey, let me remind you that *I had fuel tests made of the Arkansas coals in 1888, long before the U. S. Survey began the investigation of the fuel values of the coals of any part of this country.* The results of these tests are given in the preliminary report on Arkansas coals, pages 67 to 79, published at Little Rock in 1888, and it was expected that the final report would contain much additional data.

The reference to fuel testing, however, can hardly be taken as a real reason for your action, because I explicitly stated in my letter of February 9 that I should have to depend upon the U. S. Survey 'for such analyses and coking and fuel tests as may be necessary for the work.'

5. You seek to throw blame upon me for losses caused by errors in a map. The map referred to is given at page 390 of the twenty-second annual report of the U. S. Geological Survey, Part III. It is a sketch *map on a scale of twelve and a half miles to the inch.* If such losses ever were incurred, it is the first case I have ever heard of in which coal lands have been bought upon locations taken from a map of so small a scale.

6. The suggestion that the regular assistants of the survey must have something to do in order to earn their salaries might lead one to infer that the great bulk of the geology of the United States has been worked up and that nothing now remained but a few areas here and there like the coal fields of Arkansas. Knowing the opposite to be the truth I am unable to see that it was necessary to enter the territory of a colleague against his will for the purpose of finding work for the regular assistants of the survey.

7. In spite of the fact that my work was done eighteen years ago, and in spite of its not being up to 'present standards' you say that you were anxious to obtain it and that 'adequate payment would have been made.'

The reports of the Arkansas Geological Survey not being my personal property I leave others to characterize your proposition to pay me for one of them.

The above facts make it plain that the true explanation of your course in this matter is not frankly set forth in your three letters. The real reasons must be sought elsewhere, and I know of no place to look for them save in the general policy of the U. S. Geological Survey as reflected in its attitude toward the geologists of the country since the present director came into office.

The attitude of the survey toward the geologists of the country has come to be simply intolerable. No geologist has any rights that the survey feels bound to respect, unless indeed the geologist has political backing that makes it worth the survey's while to treat him with some sort of consideration.

If this treatment of myself and of my assistants were the first instance of the kind there might be some hope of the matter being set right; but such is not the case. Not only are our fields of operation unceremoniously invaded, but work is taken out of one man's hands to be put into another's without any reason other than the authority given by the power to do it, or through some desire to favor one person rather than another. If one asks for a reason he is grandiloquently referred to the general authorization to 'map the national domain.'

By this process not only are the rights of individuals encroached upon, but local interests are overridden, state organizations are first discredited and then driven out of existence, and even the privacy of our educational institutions is invaded and discredited in the eyes of the very people for whom and by whom they have been founded. In Arkansas the national survey gradually invaded the field of the state survey until now it would be impossible to induce the state to carry on a geological survey of its own. If members of the legislature were now asked to provide for a state survey they would simply say that such work was entirely unnecessary because if it were wanted the national survey would do it and work already done would be cited in support of the statement. By this process have the state surveys, formerly the pride of the states, been either completely wiped out or so enfeebled that they only survive with the consent and approval of the national organization. Sometimes this approval is under the form of 'cooperation' by which the state appropriates money for the use of the national survey. In some instances the director of the U. S. Survey has even gone to the extent of writing to members of state legislatures and advising against the support of state surveys unless it were done in a way to suit the national organization.

A single case of the discrediting of local geologists by the policy of the present director of the survey is sufficient to show where every teacher of geology in this country stands if the survey sees fit to use its power to discredit him.

A few years ago the national survey sent an assistant to work up the geology of the Fayetteville folio in the state of Arkansas. Fayetteville being the seat of the State University, the professor of geology in that institution, in order to save his face, was compelled to ask as a favor that he be allowed to help, in a subordinate position, to do the work on his own campus and in his own door yard. And even though this concession was finally made, he stood discredited as a geologist before the people of the state, before the trustees of the university, before his colleagues in the faculty, and before his own students. For what were they to think of him as

a geologist if some one had to be sent in from elsewhere to do the work under his very nose?

And if the professor should protest, what answer would he get? That the assistants sent to do the work are competent men; that the national survey is authorized to enter every part of the national domain; that the state institutions have not the money to do the work with; that the assistants of the survey must do something to earn their salaries. And these things are all true enough, though the total results are none the less unfortunate and none the less fatal to an interest in geology among the people. For if the national survey can thus, under cover of national authority, injure the professional reputation of the professor of geology in one university, it can do it for any professor in any college or university in this country, and we have no redress.

Against all this sort of thing I not only enter my most vigorous protest, but I can not allow my name to stand on the roll of an organization so thoroughly undemocratic, and so thoroughly out of sympathy with the local interests of the country. In my opinion a public bureau administered in the spirit that has grown up in this one ought to have no place in a republic where it is important that there should be a widespread interest in science, and above all a feeling of safety for every worker, however humble.

Finally I beg to remind you that the question here at issue is not a question of geology, but a question of the administration of a public bureau.

I remain

Yours respectfully,

J. C. BRANNER.

THE PRESIDENCY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

ANNOUNCEMENT has been made that the executive committee of the corporation of the Massachusetts Institute of Technology has selected Dr. Andrew Fleming West, professor in Latin in Princeton University, for the vacant presidency. It is ungracious to question an appointment of this character, and nothing could be gained by criticism if it were not that the corporation has not yet acted and Professor West has not yet accepted.

Professor West possesses many of the qualities that should be found in a college president. He was not elected to succeed President Patton at Princeton, but he would have been an excellent president for an institution, which more than any other of our universities or semi-universities has been imbued with his ideals. These may be illustrated by a quotation from Professor West's most recent address. He writes: "And so I return to the opening thought: The old college ideal is the true one." The opening thought was "The living root of the old faculty, as of every other part of the college, was a distinctively Christian impulse * * * the old college faculty at least professed and tried to show that God is the end of all our knowing and that Christ is the Master of the Schools."

But it is a long way from the chair of Latin in a classical and monastic college to the presidency of the Massachusetts Institute of Technology. It is to be feared that the trustees who favor the election of Professor West have been influenced by two factors. He is said to be known at Princeton as 'three-million-dollar West,' in view of his part in securing endowment for the institution, and he is known in the educational world as an opponent of President Eliot and the Harvard system. The writer once heard Professor West read a paper in which he said that the connection of the elective system and the three-year course at Harvard University was perhaps not accidental, as three years were enough of that sort of thing. But it is dangerous to cross swords with President Eliot, who replied that he had also noticed the connection between the elective system and the three-year course, but that he interpreted it as meaning that under the elective system a student could accomplish as much in three years as he could in four under the fixed curriculum.

It would seem to an outsider that in the present emergency the Massachusetts Institute of Technology needs for its president one of its own men, imbued with its methods and traditions, a man bred to science, believing in science as the chief factor in culture and in life, knowing that pure and applied science must go forward hand in hand, a man who would ally the institution with the city and the state rather than try to coax money from millionaires.

The corporation of the institute has recently met a disastrous defeat in its attempt to form a merger with Harvard University against the wishes of the faculty and alumni. Should it be so ill-advised as to elect a president without consultation with the faculty, it is to be hoped that Professor West will not accept until he assures himself of their approval. It is indeed quite possible that the election will be welcomed by the faculty, and that they will obtain a president beyond reproach—in which case science will have captured a captain from the enemy's camp.

J. McKeen Cattell.

SPECIAL ARTICLES.

A SIMPLE METHOD OF ILLUSTRATING UNIFORM ACCELERATION.

The following method of illustrating in the presence of a class (or as a simple laboratory exercise) the principle of uniformly accelerated motion exceeds in simplicity, accuracy and interest any that I have hitherto found.

A ball rolling down a groove in an inclined plank and at the same time vibrating across the groove has a constant acceleration in one direction, while its transverse vibrations are pendular motions that mark the time. If the groove be painted black and well polished, lycopodium dusted on the groove will preserve a very sharp trace of the motion of the ball. When the powder has been blown off by a wave of a fan the trace comes out with the distinctness of a sharp chalk line. The distances traversed in successive vibrations of the ball are measured along a white thread stretched accurately in the middle of the groove (or along a white paint line). The two motions should start simultaneously in the middle of the groove; this may be secured by allowing the ball to roll initially along a transverse brass strip extending to the middle of the groove.

The frictional resistance to the motion of the ball is negligible and the constancy of the ratio of linear distance to square of number of vibrations depends only on the accuracy of the measurements and the straightness of the plank.

To illustrate the principle of constant acceleration the actual period of vibration of the ball is not required; but it may be found by observation or by timing a short pendulum that vibrates in unison with the ball. The linear acceleration of the ball can readily be shown to be $5/7\ g \sin$ (inclination of plank). The vibrating ball is a simple pendulum of length equal to the distance from the center of the ball to the center of curvature of the groove; but, to calculate the period, $5/7\ g$ must be used instead of g.

Several other points of interest may be noted. The record may be obtained by dusting the powder on the groove *after* the ball has rolled down. The record can only be completely removed by a damp cloth. The track of the ball on the powder is very curious and interesting, consisting of a ridge of powder with a clearing on each side. A very striking lecture experiment is to use fine sulphur powder instead of lycopodium; if the plank be raised to a vertical position, and brought down sharply on the table the record will appear instantaneously. If the plank be horizontal, the path of the ball will be a nearly perfect simple harmonic wave. If the grooved plank be placed on an inclined-plane plank, the coefficient of kinetic friction between the two may be deduced from two records, the first with the grooved plank held at rest, the second with the grooved plank in sliding motion.

I have found a groove five feet long, four inches wide and of four inches radius and a steel ball one and a half inches in diameter very satisfactory. The groove could be chipped out in a moment on a molding machine with knives of sufficient size; but, in the absence of such facilities, a number of longitudinal saw cuts of graduated depth, made by a circular saw, will render it easy to chisel the groove out by hand.

The International Instrument Co., of Cambridge, Mass., will supply the above apparatus on order.

A. Wilmer Duff.
Worcester Polytechnic Institute,
Worcester, Mass.

CURRENT NOTES ON METEOROLOGY.

METEOROLOGY OF THE NILE BASIN.

A VALUABLE report on 'The Physiography of the River Nile and its Basin' (1906, 4to, pp. 411), by Captain H. G. Lyons, Director-General of the Survey Department of Egypt, shows how rapidly our knowledge of the physiographical and meteorological conditions of northern Africa is being enlarged. This volume, of over four hundred pages, illustrated by means of nearly fifty charts, diagrams and maps of various kinds, is very effective evidence of the energy and ability of the present chief of the Egyptian Survey Department. A second smaller publication, 'The Rains of the Nile Basin in 1905' (Cairo, 1906, pp. 40, pls. IX.), deals with the rainfall of one year. It includes monthly rainfall maps, and some interesting diagrams of Lake Victoria levels; of gauge readings for Lake Albert, Bahr el Ghazal, White Nile, Blue Nile, Atbara and Nile, and also an instructive comparative diagram of Nile floods. Much popular interest has always been excited by the famous Nile overflows. With each succeeding year the factors concerned in these overflows are more carefully worked out and more thoroughly understood.

COLD WAVES IN THE UNITED STATES.

BULLETIN P of the Weather Bureau, by Professor E. B. Garriott, deals with 'Cold Waves and Frost in the United States' (1906, 4to, pp. 22, charts 328), and is a very useful collection of charts which teachers will be able to put into the hands of classes in meteorology. In the text there is a chronological account of historical cold periods in the United States, and a summary and classification of the more important cold waves and frosts in the period 1888–1902, inclusive. A considerable body of material is here collected, in very convenient form for study, and it is to be hoped that some competent person who has the necessary time at his disposal will give these charts the attention which they merit, and will deduce from them various important conclusions which have not yet been reached concerning both cold waves and frosts.

CLIMATE OF ALASKA.

A REPORT on 'The Climate of Alaska,' by Cleveland Abbe, Jr., forming part of a recent publication on the geology and physiography of that territory, appears separately as an extract from *Professional Paper No. 45*, U. S. Geological Survey, pp. 133–200. The available records have been carefully studied and summarized, and although the conditions of observation were in many cases not all that could be desired, so far as accuracy, exposure of instruments and regularity are concerned, yet this volume presents a valuable body of information which was much needed in many quarters. The discussion in the text is clear and concise. The tabulations are well arranged and in several cases unusually complete. And there is a satisfactory recognition of the human relations which is all too rarely found in climatic reports.

COLORADO COLLEGE OBSERVATORY.

THE semi-annual *Bulletin* of the Colorado College Observatory (June, 1906) contains the meteorological statistics, with an introductory explanation, by Professor F. H. Loud, the director; 'Colorado Springs Weather Records,' by Chester M. Angell, being a table of meteorological statistics for 1872–1903, and a second paper on the 'Evolution of the Snow Crystal,' by J. C. Shedd.

NOTES.

AT a meeting of the Scottish Meteorological Society held on July 12, 1906, a paper by Dr. Alexander Paterson, of Hebron, Syria, was read, in which, on the basis of ten years' recent observations at that station, it was held that the climate is now much the same as the scriptures show it to have been 3,000 years ago.

THE Fourteenth Report of the *Sonnblick-Verein* (1905) contains an account of the observatory Reina Margherita on Monte Rosa, with a view of the royal party, including Queen Margherita, on its ascent of the Gnifetispitze.

THOSE who wish to keep up with the progress that is being made in kite meteorology will need to consult 'The Vertical Temperature Gradients on the West Coast of Scotland and

at Oxshott, Surrey,' by W. H. Dines (*Proc. Roy. Soc.*, Vol. 77, 1906, 440–458). This work was done under a grant from the British government and from the British Association.

R. DeC. Ward.

RESEARCH LABORATORY OF PHYSICAL CHEMISTRY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

The Research Laboratory of Physical Chemistry has opened with a staff consisting of seven research associates and four research assistants. The new members of the staff are Herbert T. Kalmus, M. I. T. '04, Ph.D. (Zurich), Ledyard W. Sargent, A.M. (Harvard), E. B. Spear, A.B., Manitoba, and Fred C. Mabee, A.M. (McMaster University). In addition, researches are being pursued in the laboratory by five candidates for the degree of Doctor of Philosophy and one candidate for that of Master of Science. All the members of last year's staff remain.

To one of the research workers, Mr. Richard C. Tolman, a grant of three hundred dollars has been made during the summer from the C. M. Warren Fund of the American Academy of Arts and Sciences, to enable him to construct what will probably be the most powerful centrifugal machine ever made for experimental purposes, to be used in connection with an investigation of the electromotive force produced at the two ends of a rapidly rotating solution of any ionized substance. A grant of three hundred dollars from the Rumford Fund of the American Academy has also been made to Professor A. A. Noyes, which is to be used for the construction of a calorimeter adapted to direct thermochemical measurement with solutions up to 100°.

A gift has just been made to the laboratory of a large diamond valued at three hundred and fifty dollars by the Ansonia Brass and Copper Company. This is to be used in insulating the electrode within the bomb used in the conductivity investigations at high temperatures, and will entirely eliminate the error due to contamination which has been involved in the previous work where it was necessary to use quartz insulators.

A series of twelve articles on the electrical conductivity of aqueous solutions, describing the investigations on this subject made during the last three years in the laboratory, is in process of publication by the Carnegie Institution at Washington. A large part of a revised scheme of qualitative analysis for the common elements, which has been worked out during the past year by A. A. Noyes and W. C. Bray, has just appeared in the September number of the *Technology Quarterly*.

THE PERKIN LIBRARY.

Professor Chandler, who presided at the Perkin Jubilee banquet in New York, made the following statement with regard to the proposed Perkin library:

In order to honor the name of our distinguished guest for all time, it is proposed by the committee of 150 chemists and other prominent citizens who have organized this jubilee celebration, to establish in New York City a complete chemical library in duplicate; one set of books to constitute a permanent reference library always available for any one who wishes to consult it at the home of the Chemists Club, and one set equally complete for circulation throughout the country among the members of the chemical profession.

It can be truly stated that there is not a complete chemical library in the United States. Several of our larger universities have fair libraries, but each one of them lacks something that the searcher is sure to want. Moreover, these libraries are not accessible to many of the chemists. There are now about 8,000 professional chemists in the United States—teachers in our universities, colleges and high schools; professional consulting chemists and chemists in manufacturing establishments, water works, experiment stations, etc. Very few of them have access to even a respectable chemical library.

It is proposed that the circulating library shall be cared for by two or more thoroughly educated chemists to whom any chemist in the United States may apply for information on any chemical subject. The chemists in charge will keep reference lists of the best books and

journal articles on every chemical subject and supply this information when called for, and if desired, send the books containing the references by express.

It is even proposed to make arrangements to have articles copied if necessary, and even to have translations made. In other words, it is hoped that with proper endowment and proper support the Perkin Library will become of the utmost value to the chemical profession. All that is necessary is the interest and cooperation of the chemical profession and some assistance from others.

SCIENTIFIC NOTES AND NEWS.

ON the occasion of the dedication of the new engineering building of the University of Pennsylvania on October 19, honorary degrees of doctor of science were conferred as follows: Alexander MacKenzie, colonel of the United States Engineers; Samuel Sheldon, professor of physics and electrical engineering in the Brooklyn Polytechnic Institute; Mansfield Merriman, professor of civil engineering in Lehigh University; Frederick P. Stearns, chief engineer of the Boston Metropolitan Water Board; Edgar Marburg, professor of civil engineering in the University of Pennsylvania; Charles Whiteside Rae, engineer in chief of the United States Navy; Henry Wilson Spangler, professor of mechanical and electrical engineering in the University of Pennsylvania; M. M. H. Vetillart, representative of the government of France at the dedication; Frederick Winslow Taylor, consulting mechanical engineer, of Philadelphia; Samuel Matthews Vauclain; John Fritz, mechanical engineer, Bethlehem, Pa., and Ramon Icarrola, representative of the Mexican government.

SIR DAVID GILL, astronomer royal in South Africa, is about to retire from the active duties of the position.

THE third course of lectures on the Herter foundation at the Johns Hopkins University was delivered by Sir Almroth E. Wright, M.D., F.R.S., late professor of pathology in the Army Medical School, Netley, and pathologist to the St. Mary's Hospital, London. The subject of the lectures was 'The therapeutic inoculation of bacterial vaccines and its application in connection with bacterial disease.'

DR. W. OSLER delivered the Harveian oration at the College of Physicians, London, on the eighteenth inst.

THE seventh annual Huxley memorial lecture of the Anthropological Institute will be given on November 1, when Professor W. M. Flinders Petrie, F.R.S., will deliver an address on 'Migrations.'

THE National Health Society will hold a public meeting at University College, London, on October 29, to discuss the subject of the purity of the meat and milk supply. The chair will be taken by Sir Frederick Treves, and among the speakers announced are Sir William Broadbent and Sir James Crichton-Browne.

THE Bradshaw lecture before the Royal College of Surgeons of England will be delivered by Mr. Edmund Owen, December 12, the subject being 'Cancer: its treatment by modern methods.'

MR. F. W. LEVANDER has been nominated for president of the British Astronomical Association. The election will take place at the annual meeting on October 31.

DR. ROBERT E. COKER has resigned the Adam T. Bruce fellowship in biology in Johns Hopkins University, having been appointed by the Peruvian government to take charge of the work in connection with the marine fisheries in Peru.

MR. LOUIS J. DE MILHAU, A.B. (Harvard, '06), and Mr. John W. Hastings, A.B. (Harvard, '05), A.M. (Harvard, '06), have been appointed members of the Peabody Museum staff as ethnologists of the South American Expedition.

DR. G. C. SIMPSON, lecturer in meteorology at the University of Manchester, has been appointed assistant to the director of observatories under the Indian government.

J. B. MOWRY has been appointed commissioner of forestry in Rhode Island.

MR. J. J. DEARBORN, of the Harvard Forestry School, has been appointed assistant to

Professor F. W. Rane, state forester of Massachusetts.

Dr. G. H. Whipple has been appointed assistant pathologist at the Johns Hopkins Hospital, to succeed Dr. C. H. Bunting, who has resigned to accept the position of professor of pathology at the University of Virginia.

Dr. Henry M. Hurd, professor of psychiatry in the Johns Hopkins Medical School, has been given a year's leave of absence and will spend it in Europe, leaving about November 15.

A Reuter message from Wellington, New Zealand, reports that a monument to Captain Cook was unveiled on October 8 in the presence of a large gathering of both races at Poverty Bay, on the east coast of the North Island, at the spot where the explorer landed.

The German Dermatological Society has decided to subscribe 5,000 Marks to the Fritz Schaudinn fund, and to give the first volume of the society's publications the title 'In Memoriam Fritz Schaudinn.'

The Museo Goeldi at Para, in Brazil, desires an American naturalist, a young man of solid character, who can adapt himself to new surroundings, as taxidermist and general preparator in the museum. Application may be made to Dr. Goeldi, 399 Caixa Postal, in Para, or to Dr. John C. Branner, at Stanford University, Cal.

Sir George Darwin has invited the International Geodetic Congress to meet at Cambridge in 1909.

Since October 1, 1906, no publications are sold by the Nautical Almanac Office or by the Bureau of Equipment. All orders for copies of the *American Ephemeris, Nautical Almanac* or astronomical papers should now that date be addressed to the superintendent of documents, Government Printing Office, Washington, D. C.

We learn from the *Journal of the American Medical Association* that the mother of the late professor of chemistry at Basle, George W. A. Kahlbaum, has presented $9,500 to the National Society for the Study of the History of Medicine and Science, which was recently founded by her deceased son. She has also given the Berlin branch of the same society $5,000.

The Chemical Engineer states that the committee on the purity of reagents of the American Chemical Society, J. H. Long, chairman, has decided that it is inadvisable at this time to publish a book on the testing of reagents, as the amount of new data collected is so small that such a work would be only a duplicate of the well-known work of Dr. Krauch. It was also decided to limit the work of this committee, in the immediate future, to the commoner acids and alkalies, and to send out circulars to prominent manufacturers, in this country and Europe, inquiring as to the methods in use by them for testing for impurities found in the reagent grades of these acids and alkalies. Dr. H. N. Stokes, of the Bureau of Standards, has been chosen secretary of the committee. This bureau now has two chemists working upon methods of testing for reagents. So far their attention has been chiefly devoted to perfecting an accurate colorimetric method for determining traces of iron in reagents.

Two years ago, after two years' continuous effort, the New York Zoological Park secured a fine specimen of the almost extinct California condor. The bird has been kept in fine health until a few days ago. Last Saturday, however, it showed signs of illness, and on Tuesday it died, evidently in great pain. Previous to the autopsy its death was a mystery; but Dr. Blair's examination soon revealed the cause. This fine bird, worth at least $300, and the only specimen obtained in four years, was killed by a large rubber band, presumably administered by some visitor. The rubber band had lodged in the pyloric orifice of the stomach, completely closing it, and arresting the entire process of digestion. It is such exasperating occurrences as this and the murder of a valuable bear with four peach-stones that compel the Zoological Society to forbid the feeding of animals by visitors. Hereafter the vigilance of the keepers and police will be redoubled, and visitors must refrain from offering any object to any of the wild crea-

tures in the Zoological Park, whether mammal, bird or reptile.

The British Medical Journal states that during the weeks ended August 18, 25, and September 1 and 8 the number of deaths from plague in India amounted to 1,451, 2,113, 2,522 and 3,134, respectively. The principal figures are: Bombay Presidency, 879, 1,288, 1,388 and 1,850; Bengal, 70, 97, 115 and 83; United Provinces, 109, 164, 49 and 163; Central Provinces, 99, 109, 190 and 362; Madras Presidency, 8, 100, 9 and 10; Burmah, 182, 132, 112 and 92; Central India, 0, 197, 303 and 362. Baluchistan and the Frontier Provinces remain free from the plague. The worst area in the Bombay Presidency was Poona City, with 439 seizures and 399 deaths. Bubonic plague in monkeys and cats is reported from two districts in the United Provinces. In the jungles a number of wild animals are reported to have died of the disease.

WE learn from the *Experiment Station Record* that in order to make better provisions for research work in forestry, and to secure a permanent staff of forest experts for scientific research, as well as for training candidates for the government and state forestry service, the Imperial Forestry School at Dehra Dun, India, has been enlarged and hereafter will be known as the Imperial Forestry Research Institute and College. The college staff will include officers of the imperial service, holding the following positions: (1) Sylviculturist, who will make sylviculture his special study. (2) Superintendent of forest working plans, who will collect and collate statistics of the results of forestry management throughout India. (3) Forest zoologist, who will investigate the damages caused by insects and other pests. (4) Forest botanist, who will study the botany of forest plants, distribution of species, diseases of forest trees, etc. (5) Forest chemist, who will investigate the chemical properties of soils and forest produce. (6) Forest economist, who will study economic methods of commercial timber production and marketing. These officers, while engaged primarily in research work, will each deliver a course of lectures on his special subject in the college, and take part in the training of the students. The work of instruction, however, will for the most part be carried on by four assistant instructors.

IT is stated in *Nature* that the opening session of the International Congress on Methods of Testing was held in the Palais des Académies, Brussels, on September 3, under the presidency of Mr. F. Berger (Vienna). Five hundred members were present from eighteen different countries. Addresses of welcome were delivered by Count de Smet de Naeyer, the Belgian prime minister, and by Mr. H. Raemarckers, secretary of the Department of Railways. An address was then given by Professor F. Schüle (Zurich) in memory of the deceased president, Ludwig von Tetmejer. A report on the work of the executive council since the last congress was presented by Mr. Berger, and interesting papers on the iron and steel industry of Belgium and on the Belgian cement industry were read by Baron E. de Laveleye and Mr. E. Camerman. The mornings of September 4, 5 and 6 were devoted to the work of the sections and the afternoons to excursions. Excursions to the works of the Cockerill Company at Seraing and to Ostend were arranged for September 7, 8 and 9. The congress is held under the patronage of the King of the Belgians, who on September 2 received the members of council.

ACCORDING to the *Electrical World,* the Vienna Imperial Academy of Sciences has announced the result of its examination of uranium earth from the Joachimsthal state mines in Bohemia, conducted in the academy's laboratories in Vienna. About 50 tons of earth were subjected to tests and experiments, yielding radium products worth at the present market price more than $200,000. Dr. Hartinger conducted the investigation. The products thus obtained will not be sold, but will remain the property of the academy and will be used for further scientific research. The Austrian ministry of agriculture has decided to build its own laboratories at Joachimsthal for the production of radium salts. It is also proposed to exploit the healing properties of radium by establishing a health resort and using the springs in the mines for curative purposes, both in baths and for drinking.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. John A. Creighton, one of the founders of Creighton University, Omaha, Nebr., has deeded to that institution two buildings in the wholesale district, worth about $500,000.

Victoria University, of Manchester, has received £5,000 from the trustees appointed under the will of Miss Middleton, which will be used towards endowing the chair of anatomy.

The Boston *Transcript* states that at a meeting of the board of regents of the University of Kansas, a proposition was presented by Chancellor Strong to ask Mr. Andrew Carnegie for money with which to build a new fine arts building, but the proposition was voted down.

Mr. William A. Marburg, of Baltimore, has presented the Johns Hopkins Medical School with a valuable collection of medical books.

The new administration building of the Colorado School of Mines, which is to be known as Simon Guggenheim Hall in honor of the donor, was dedicated with appropriate ceremonies on October 17. The dedicatory address was delivered by the Rev. Dr. F. W. Gunsaulus, president of Armour Institute. Short addresses were also made by Rabbi W. S. Friedman, of Denver, and by Mr. George M. Post, in presenting to the school portraits of the donor and of the former president of the school, Dr. Regis Chauvenet, these portraits being the gift of the alumni. A large audience was present, including a delegation from the American Mining Congress, and representatives from the other educational institutions of the state.

Mr. Andrew Carnegie recently opened the new engineering and natural philosophy departments of the Edinburgh University, which were largely erected owing to his gifts. Mr. Balfour, chancellor of the university, in thanking Mr. Carnegie, Lord Elgin and other contributors to funds, conferred the degree of doctor of laws on Mr. Carnegie and Lord Elgin.

The senior officers in each department of study in the two undergraduate departments of Yale University and some others have had their annual salaries fixed for the coming college year at $4,000. The total number of professors affected by this change is about thirty-five. The salary list of the departments mentioned has been increased by about $9,000 by this rearrangement.

The chair of geology, at Vassar College, vacant by the death of Professor William B. Dwight, has been filled by the appointment of Dr. George B. Shattuck, associate professor at the Johns Hopkins University.

Dr. Arthur B. Lamb, instructor in electrochemistry at Harvard University, has been appointed assistant professor of chemistry and director of the Havemeyer Chemical Laboratory at New York University, in succession to Professor Morris Loeb.

John Charles Hubbard, Ph.D. (Clark), assistant professor of physics at New York University, has been appointed assistant professor of physics in the collegiate department of Clark University, Worcester, Mass.

The medical department of the University of Pennsylvania has established a department of experimental surgery, and Dr. J. E. Sweet, formerly connected with the laboratory of hygiene, and more recently with the Rockefeller Institute, has been placed in charge.

Dr. Alfred Schalek, of Chicago, has been appointed professor of dermatology and genito-urinary diseases in the medical college of the University of Nebraska, Omaha.

Dr. T. M. Taylor has resigned the position of instructor in chemistry at Oberlin College, which he has held for the past five years, to become a member of the faculty of the Carnegie technical schools at Pittsburg. His place will be taken by W. H. Chapin, 1904, who has resigned a fellowship in chemistry at the University of Pennsylvania to remain at Oberlin.

Dr. Zdenko Skraup, professor in the University of Graz, has been appointed professor of chemistry in the University of Vienna, in succession to Professor Adolf Lieben, who has retired.

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THE CONCURRENCE AND INTERRELATION OF VOLCANIC AND SEISMIC PHENOMENA.[1]

THE noteworthy occurrences that have latterly so largely engaged the attention of vulcanologists and seismologists, and so deeply impressed the world with the sense of insecurity that attaches to life upon a still unstable planet, make perhaps pertinent at this time a re-inquiry into some of the general phases of the phenomena as they are thought to be known to us. In announcing certain conclusions in this paper which are at variance with the views held by seemingly the greater number of geologists, or at least the specialists in the fields of inquiry which the paper touches, the author recognizes that the facts or data bearing out his conclusions may be thought by some to be presumptive rather than positive; but, whether so or not, he believes they are of a kind that must be taken account of in whatever phase the inquiry is pursued, and that they are at least of equal value with those that are assumed to uphold the opposed or generally received conclusions.

The two most important contributions to our knowledge of volcanic and seismic

[1] Paper read before the Tenth International Geological Congress, held in the City of Mexico, September 6, 1906.

phenomena that have been made during many years, are, as I take it, to be found in the records of the disturbances that have for many years agitated Japan and in the cataclysmic events which in 1902 visited the Antillean and Gulf regions of America. These additions to knowledge may be briefly summarized as follows:

1. The recognition of the fact that in perhaps the most seismic portion of the earth's surface—and by application, not unlikely over the whole world—earthquake disturbances, especially those of greater magnitude, are almost invariably preceded, by from one to five or six days, by marked magnetic disturbances in the earth's superficial crust.

2. The close connection existing over vast areas of the earth's surface, as measured on the direct east-and-west line uniting Quetzaltenango, in Guatemala, with Martinique, between the earthquake and volcanic disturbances of a single or identical period of activity.

The relations of magnetic disturbances to earthquakes in the Japanese region would seem to be clearly indicated in the records of the earthquakes of Nagoya (Dec.–Jan., 1893–4), Shonai (Oct., 1894), the great seismic 'tsunanie' of June, 1896, Ugo and Rikuchis (1896), Rikuzen (1900), etc., which have been discussed in the reports of the Earthquake Investigation Committee of Japan. While it may be true, as this committee wisely reports, that 'careful examination and extensive comparison with magnetic observations abroad, as well as records of earthquakes and pulsatory oscillations,' will be required before any relations between the two phenomena can be considered as definitely established,[2] yet the facts are such as to leave little room for doubt in the premises. Indeed, we have the positive statement made by Yamasaki, in an address delivered before the geographical section of the University of Vienna, that every major earthquake that visited Japan during the ten years immediately preceding 1902, and most of the minor ones, were heralded in advance by magnetic disturbances. If such be the case, and there would appear at this time to be no good reasons for assuming that the facts are different from what they have been represented to be, then manifestly the *cause* of earthquakes (and here a special reference is made to those that are referred to as 'tectonic') must be sought for in conditions that have no immediate relation to rock displacements of the time of the earthquake itself—in conditions that may at this time be wholly beyond the field of investigation, and whose expression may be found in some special magnetic or electromagnetic quality of our planet. The remarkable magnetic disturbance which accompanied or followed the cataclysm of Pelée on May 8, 1902, and which in an interval of from less than a minute to two minutes was registered in nearly all the magnetic observatories of the world, from Maryland to Paris, Athens, Honolulu and Zika-wei, in China, may point to some significance in this connection.[3]

The logical deduction from the premise that has been stated must necessarily be, it seems to me, that, however pointedly a displacement along a line of faulting or elsewhere would seem to indicate the *cause* of an earthquake, such displacement must rather be looked upon as a *consequence* of the seismic jar. In other words, the slipping or torsion of a terrane did not make the earth-jar, but, on the contrary, it fol-

[2] Publications E. I. C., Tokyo, 1904, p. 81.

[3] The effect of strain within the earth's crust or mass as of itself initiating magnetic disturbance is not considered in this paper; but the subject has possibly an important place in this inquiry, and its elucidation may help to clear up some of the mystery that attaches to seismo-magnetism.

lowed in obedience to an impact already delivered, and naturally along lines of predetermined weakness. Indeed, there are many reasons for believing—but the facts can not be discussed in this place—that extensive slips along breakage-lines or lines of fracture, in any way correspondent to the long line of displacement which marked the late California earthquake, could not have been initiated without a precedent jar or impact; and still less could there be initiating displacement along a line of contact such (*e. g.*, between the looser materials of the coastal plain of the eastern United States and the compact sub-Appalachian border-rock) as had been advanced to explain the Carolina earthquake of 1886.

The extent of field which may be covered by interrelated volcanic and seismic disturbances of one period of activity, as is evidenced by the Antillean events of the year 1902, bears directly upon the question of the causation of certain earthquakes which have hitherto been thought to be of a purely tectonic character. The facts connected with the Antillean disturbances are briefly:

The destructive earthquake of Quetzaltenango, in Guatemala, on April 17–18, at almost precisely the time when Pelée first seriously manifested its new activity; the renewal of activity, immediately after the earthquake, and at a distance of nearly 200 miles, of Izalco, in Salvador, a volcano whose energies had calmed down for a number of years, but which was in full activity on May 10, two days after the Pelée cataclysm; the eruption on May 7, of the Soufrière, in St. Vincent; the cataclysm on May 8, of Pelée, followed, as in the case of the Soufrière, with violent disturbances extending into September or October; the eruption on October 24 (and continuing to Nov. 15) of Santa Maria, in Guatemala, a volcano situated close to the seismic field of Quetzaltenango, and for which there is no recorded previous eruption. The relation of these facts, it seems to me, is so conclusive that one need hardly discuss the probability of another interpretation being found for them; and it was not without reason, therefore, that Milne early advanced the view that the April earthquake of Quetzaltenango was the real initiator or instigator of the series of dual disturbances that followed rapidly upon it. The lid was taken off the boiling pot, and the pot exploded. Whether or not one should extend the relation of disturbances so as to include the earlier earthquake which in January of the same year wrecked a large part of the town of Chilpancingo, in southern Mexico, and the reawakening of Colima in February and March of the year following (1903), does not materially affect the problem, as the distance separating Martinique from Quetzaltenango is already so great as to fully satisfy the broad deduction which it is the aim of this paper to present. Owing, perhaps, to the fact that these disturbances were developed in what might be termed a single region, and in a region that is not familiar to us in the sense that parts of the world nearer to our homes are, the geologist is not apt to be impressed with the magnitude of the distance that separated them; it is, therefore, proper to state that on the map of the continent of North America it would be measured by the line uniting Galveston with Cape Churchill, on Hudson Bay, or that uniting San Francisco with the volcano of Iliamna, on Cook Inlet, Alaska.

Applying the test of distance in a possible relation touching the history of other (so-called 'independent') earthquakes, we find some not wholly uninteresting results. Thus, the great earthquake of Lisbon (1755), seemingly the most destructive of all the seismic disturbances which history

records, and which is ordinarily considered to be typical of the so-called tectonic earthquake (or earthquake independent of volcanic association), took place in a field which in a direct line is removed by 1,800 miles from the very active volcanic region of Iceland—therefore, at a shorter distance than Pelée is from Quetzaltenango. It is significant that a few days before the destruction of Lisbon the volcano of Kötlugia, in Iceland, broke out into violent eruption, and it is perhaps more than a coincidence that on the very day of Lisbon's fall (November 1) the activity of this volcano was particularly marked.[4]

It would perhaps be going in advance of the facts were we to immediately assume that the eruption of Kötlugia was directly related to the Lisbon earthquake; on the other hand, there would seem to be nothing to make this conclusion untenable. Indeed, this relation acquires a strong degree of confirmation from the events that a few years later (1783) marked the very disastrous earthquake of Calabria. At that time, although following the great shock (March 28) by several weeks, the volcano of Skaptar Jökull, in Iceland, went through its greatest paroxysm, discharging lava for a period of four months, and relieving the interior of the earth of a mass of rock-material which has been estimated to have been not less than 27 milliards of cubic meters—the equivalent of a block six and one fifth miles long, three and one tenth miles broad and 1,771 feet thick! The volcano of Reykjanes was likewise in eruption. These two volcanoes are located almost exactly 2,000 miles from the scene of the Calabrian disturbances, when the entire island of Sicily, in addition to the mainland of Italy, was affected. The same year witnessed also the explosion of Asamayama, in Japan, one of the most violent of all recorded eruptions, when rocks measuring 40 to 260 feet across are said to have been hurled out of the crater.[5] It should also be noted that this year marked the first recorded eruption of Irazú, in Costa Rica, which was accompanied by violent earthquakes.[6]

A partial and perhaps even very close parallel to the Antillean occurrences of 1902 may be found in the disturbances which framed the New Madrid earthquake in the valley of the Mississippi in (December) 1811 and 1812, that wrought the destruction of Carácas on March 12, 1812, and culminated in the great eruption of the Soufrière of St. Vincent on April 30, 1812. The association of events in these cases is such as hardly to permit of doubt in their reference. Indeed, it has been frequently stated (but I have not been able to find absolute confirmation of this assumed fact) that the movements in the Mississippi Valley ceased for a while, almost immediately with the breaking out of the Soufrière. A similar, although reversed, condition marked the earthquake of Riobamba, on February 4, 1797—perhaps the most destructive to life after that of Lisbon—when, as we are informed by Humboldt, the volcano of Pasto, situated 200 miles distant, almost immediately ceased smoking.[7]

The great earthquake which on February 20, 1835, destroyed the city of Concepción, in Chile, and which has been represented to be a distinctively tectonic quake[8] is almost certainly one of volcanic association, and so it has been referred by Milne, in his work on earthquakes (p. 135). The year 1835 was a particularly volcanic year in the Chilean Andes, and the reports of the

[4] 'Royal Society Report on Krakatoa Eruption,' p. 387.

[5] Milne, British Association Reports, 1887.

[6] Milne, 'Earthquakes,' p. 273.

[7] 'Views of Nature,' Bohn edition, p. 175.

[8] Dutton, 'Earthquakes,' p. 52.

officers of the *Beagle,* which happened to be at Concepción at the time of the earthquake, make clear reference to volcanic outbursts, one behind the island of Quiriguina and the other in the bay of San Vincente.[9] In the Royal Society Report on the Krakatao eruption we find the statement that all the Chilean volcanoes were active on the fatal February 20—a statement that in its broad reference, I believe, still requires verification. This earthquake was followed within a period of less than a month (March 15) by the great earthquake of Santa Marta, in Colombia and was preceded in the same period by the cataclysm of Coseguina, in Nicaragua (January 20, 1835), probably the most violent of all the paroxysms that had been reported up to its time from the American volcanoes.

The difficulty of distinguishing between so-called tectonic earthquakes and those having a volcanic reference has always been great, and it naturally increases the moment we fully recognize over what vast distances the interrelationship of the two classes of phenomena may be established. This condition was, indeed, long ago appreciated by Milne, who, in his work on 'Earthquakes' already referred to, very guardedly attempts to make the distinction upon which other seismologists, notably Montessus de Ballore, so positively insist. He accurately states the position, it seems to me, when he asserts that both phenomena may be merely 'different effects of a common cause' (p. 275) or as resulting from 'some great internal convulsion' (p. 270) —in which case 'an earthquake may be looked upon as an uncompleted effort to establish a volcano' (p. 275).

The few instances that have here been cited to show a very probable interrelationship between far-removed manifestations of volcanic and seismic disturbance may be considered insufficient to establish the relation which it is the aim of this paper to present, but it would not be difficult to largely multiply the cases of such apparent correspondence. They certainly suffice at this time to make very doubtful the commonly accepted limitation of the two main classes of earthquake disturbance, and show almost to a certainty that some, at least, of the most destructive earthquakes have been wrongly referred.[10] If it should be objected that a number, or even a very large number of the most far-reaching and, therefore, most typically 'tectonic' quakes, such as that of Arica, of August 13, 1868, or of Lima, of October 28, 1746, have seemingly not even a distant eruption on which to couple their history, it may be replied that many such quakes have been recognized to be of distinctively marine origin, and they could be easily related to a violent suboceanic eruption whose traces need in no way be made apparent at the surface. That such suboceanic eruptions do take place, no geologist denies, and it is further believed by many (as, for example, Rudolph) who have given the closest study to the nature of the great oceanic waves that have accompanied (or preceded or followed) some of the most violent seismic movements, that these waves have an absolutely volcanic origin—the waters being depressed or elevated as the result of volcanic and not of earthquake stress. It should also be noted in this place that a lack of synchronism in time by weeks or even months is not necessarily opposed to an assumption of interrelationship in action, since the *mani-*

[9] *Journ. Royal Geog. Soc.,* Vol. VI.

[10] As bearing further on this point it may be noted that the earthquake known as that of Valdivia, Chile, of 1822, whose effects were felt over a north and south extent probably considerably exceeding 2,000 miles, is classed by Dutton among the tectonic quakes, whereas by Milne it is placed among those having a volcanic association.

festation of action as it presents itself to us in time need by no means represent the *actual* time-period which marked the beginning or end of a disturbance, whether volcanic or seismic.

If we once assume, and as the facts seem to indicate justly, that an interrelation between volcanic and seismic distui bances may be extended over a region of 2,000 miles or more, naturally it becomes impossible to state to what further limits this relationship may not extend; in other words, how far removed may a volcano be from an earthquake to be brought into correspondence with it. This question can not now be answered, but it is certainly a significant fact that a very large number of the greater earthquakes have been at (or about) times when there have been violent or paroxysmal eruptions, however distantly removed the points of such eruption may have been. And it can also be stated that extreme volcanic activity in one part of the globe is frequently synchronized, or shortly followed, by similar activity elsewhere. This, in a measure, and perhaps equally so, holds true of earthquake disturbances. These conditions, taken in connection with the facts that have been earlier recited in this paper, it seems to me, tend to prove that a causal bond unites the two classes of phenomena, and that they have a common origin in some internal planetary stress or convulsion.

It has been claimed by those who sharply distinguish between volcanic and tectonic earthquakes that the earth movement, whether in force or in lateral extent, that distinguishes the former is small compared with that of the latter, but the facts that have already been brought forward render the accuracy of this conclusion extremely doubtful.[11] Indeed, the geologist, in the face of the far-reaching mechanical work of evisceration which so largely distinguishes many eruptions, would on *a priori* grounds be justified in hesitating before he announced this conclusion, and he could ask himself the much-neglected question: what must be the result of the removal in a short period of so much material from the earth's interior? The volcano of Askja, in Iceland, as a result of its eruption on January 4, 1875, is estimated to have thrown out from the rifts of the Mývatus Oræfi lava which in quantity measured 31,000,000,000 cubic feet, or the equivalent of a block 20 miles long, 5 miles wide and 100 feet thick.[12] The discharge from Skaptar Jökull, in 1783, was calculated, as we have already seen, to have equaled a block 6.2 miles long, 3.1 miles broad and 1,771 feet thick; that from Bandai-San, Japan, in 1888, 1.2 cubic kilometers; from Krakatao, in 1883, 4.3 cubic miles (!); and from Temboro, on Sumbawa, in 1815 (as estimated by Verbeck), 28.6 cubic miles. The geologist is in the habit of looking complacently upon the removal of this vast material from the earth's interior, but is it at all likely to have been accomplished without prodigious jarring of the earth's crust somewhere? It is only when we begin to properly appreciate the vastness of this evisceration that we are prepared to receive, apart from other evidence, the probability of far-reaching action in the eruption of a volcano. Even the minor quantity of material

[11] The breaking into activity of Klutchevskaya, the lofty volcano of Kamtchatka, on October 6, 1737, seems to have been the occasion of an earthquake which agitated nearly the whole of the Kamtchatkan peninsula and a large part of the region of the Kuril Islands. The earthquake which in 1861 annihilated the town of Mendoza, in Argentina, costing the lives of probably not less than 10,000 inhabitants, was coincident with the opening of the volcano of Mendoza near by; the earthquake of Arequipa, Peru, in 1868, was coincident with the opening of one side of the volcano of Arequipa (Misti).

[12] W. G. Locke, 'Askja,' 1881, p. 26.

thrown out by Skaptar Jökull would equal in quantity that which could be heaped up to a thickness of some seven or eight feet over almost the entire area which in California lies between the line of displacement in the recent earthquake and the Pacific Ocean; while the discharge from Temboro, if properly estimated, would have filled in a mile-wide canal to a depth of ten feet over a length of 15,000 miles. One may well stand appalled by these figures, but they have as yet produced little impression upon the geologist to whom the major lesson of vulcanology is taught by Vesuvius or Etna.

The general conclusions arrived at in this paper are:

1. A broad interrelationship exists between volcanic and seismic phenomena generally;

2. Interrelated manifestations of volcanic and seismic activity may extend over distances, as measured on the surface of the globe, of hundreds or even thousands of miles;

3. 'Tectonic' earthquakes, so-called, are only doubtfully to be distinguished from earthquakes of volcanic association, or those that have been brought about as the result of deep-seated strain;

4. The slipping, upheaval and torsion of terranes as accompaniments of earthquake action are the resultants of impacts or jars already delivered to the earth's crust, and are not the cause of such jars;

5. Earthquake and volcanic disturbances seem to be the expression of one common interior telluric strain or condition, and this condition may in some or many cases be clearly associated with a pronounced magnetic or electro-magnetic quality of the planet;

6. There would appear to be a marked synchronism or close following of major disturbances, whether volcanic or seismic, at distantly removed points of the earth's surface at certain periods.

ANGELO HEILPRIN.

SCIENTIFIC BOOKS.

The Adjustment of Observations by the Method of Least Squares with Applications to Geodetic Work. By THOMAS WALLACE WRIGHT, M.A., C.E., professor emeritus, Union College, formerly assistant engineer, Survey of the Northern and Northwestern Lakes. With the cooperation of JOHN FILLMORE HAYFORD, C.E., Chief of the Computing Division and Inspector of Geodetic Work, U. S. Coast and Geodetic Survey. Second edition. Pp. ix + 298. New York, D. Van Nostrand Company. 1906.

The average man of science generally exhibits a remarkable lack of ordinary common sense when dealing with the method of least squares and its conclusions. Inferences are drawn from a series of observations, and deductions made from the size of the probable error which at times seem so totally at variance with the truth that much fault has been found with the method. In theory, the probable error is based on the assumption that the errors are all accidental, that is, are just as likely to be positive as negative, and that there are a large number of observations, whereas in practise, the formula for finding the probable error is often applied to a very few observations not freed from their systematic or constant errors. A consequence of this is that a degree of precision is shown which is much greater than the observations themselves really warrant, and the probable error, therefore, does not seem an accurate measure of the error committed.

There are other scientists who believe that a least square reduction is a great correction of evils, and that by its means very satisfactory results may be derived from an indifferent set of observations. While poor observing will give nothing but poor conclusions, it seems to be quite a favorite trick of the computer, nevertheless, to introduce new unknowns into the observation equations with the hope of more correctly solving them. When

the sum of the squares of the residuals is diminished by this process, it is taken as a proof by the average computer that the introduction of the new unknown represents a closer approximation to the truth. As a matter of fact it is easily shown that the new unknown will *always* reduce the sum of the squares of the residuals, and consequently these diminished numbers are no proof of greater accuracy.

It is with the spirit of caution born of long practise that Wright and Hayford approach the subject. In the preface of the present volume, which is a second edition of Wright's 'Treatise on the Adjustment of Observations,' Mr. Wright tells us that so much of the new work is from Mr. Hayford's hands that it is no more than right that his name appear on the title page. The first edition is a very excellent book and has for years been recognized as the practical standard. The second edition is, if possible, better than the first, for it adds the great experience that Mr. Hayford has had in the work of the United States Coast and Geodetic Survey as chief of the Computing Division.

This experience is shown in chapter IX., wherein the principles of least squares are applied to a very important but little employed use, namely, that of the selection of methods of observations, for it may be possible for the observer either to increase the accuracy of his work by different instrumental methods or, on the other hand, to attain a given standard of excellency by a smaller amount of observing. The suggestions for applications to latitude and longitude determinations, the student of geodesy will find very helpful indeed.

The great advance in geodetic work during the past quarter of a century will be seen by referring to p. 349 of the first edition (published in 1884), wherein it says that,

> During the present century two forms of apparatus have been used in the measurement of primary bases, the compensation bars, and the metallic-thermometer apparatus. * * * Indications are not wanting that both forms will be supplanted before long by an apparatus consisting of simply a single metallic bar.

Since this was written the iced-bar and steel tape have made great changes in geodetic work.

The method of least squares which derived its birth from Legendre's attempt to find the figure of the earth thus receives a notable addition by its application to present geodetic problems.

S. A. Mitchell.

Technik des physikalischen Unterrichts. Von Freidrich C. G. Miller. Berlin, Otto Salle. 1906.

This volume of 364 pages is, as its title suggests, designed for the assistance of the instructor who must give a series of experimental demonstrations before a class beginning the study of physics. As is indicated by the preface, and also by the subject matter of the book, the class of students for whom the lectures have been especially designed would correspond in this country to college students in their first or second years.

The work is divided into thirteen parts: General Arrangements for Physical or Chemical Instruction, Measurements and Weighing, Statics, Dynamics, Statics and Dynamics of Liquids, Statics and Dynamics of Gases, Acoustics, Heat, Optics, Magnetism, Electrostatics, Electrodynamics, Introduction to Chemistry. Under each of these heads various important experiments are described in detail, and nothing could be clearer than the directions and suggestions. The author emphasizes at every point the necessity of the demonstrations being made in a quantitative manner, and he indicates the most suitable means by which measurements of all kinds can be made in such a manner as both to be accurate and to be visible to a comparatively large audience.

The book is by far the best of its kind that has come to the attention of the reviewer. It is not exhaustive, it is true, nor is it exhausting in its details. It should prove of value to every lecturer in physics and chemistry who has to deal with elementary classes.

J. S. Ames.

SCIENTIFIC JOURNALS AND ARTICLES.

The Museums Journal of Great Britain for September contains the following articles: 'On a Collection to Illustrate the Origin and Structure of Rocks,' by H. C. Sorby; 'A Method of Exhibiting Coins,' by F. R. Rowley; 'Notes on Models of Protozoa,' by F. R. Rowley; 'On the Hanging and Care of Pictures,' by Richard Quick; and 'A Method of Preserving Tortoises,' by J. E. Duerden. The reports of a number of museums are noted, giving a good idea of the general activity in museum work in England, as well as showing how much is being done there to make museums at once interesting and instructive to the general public. It is stated that it is the intention to make the Tolcross branch of the Glasgow Museum a museum for children.

The following extract from the report of the Stockport Museum deserves a wide circulation: "Many people do not realize that the true foundation of a municipal museum is educational, seeming to regard it as a receptacle for their useless old lumber and rubbish."

The Report of the Manchester Museum, Owens College, for 1905–1906, shows a welcome improvement in its finances, due to an extra appropriation by the university, which already furnishes the major part of the $14,000 (in round numbers) devoted to its support. Dr. Hoyle's address, 'The Education of a Curator,' is reprinted as one of the museum publications and should be widely read. There are still people who inquire if a curator needs any special training and apply for a position as curator of anything.

The Report of the Curator of the museum of the University of Michigan shows progress in rearranging and caring for the collections, and gives an outline of the summer's work in the ecological survey of Isle Royale. Under the direction of Mr. C. C. Adams the museum work seems to have been carried on in the best possible manner for a university museum, but it is doubtful if Mr. Adams's remarks as to the benefits of explorations can be applied indiscriminately to *all* museums. Mr. Adams has just accepted a position in the Museum of the Cincinnati Society of Natural History where his energy and experience in museum work will be of great service.

SOCIETIES AND ACADEMIES.

THE AMERICAN PHILOSOPHICAL SOCIETY.

THE program for the stated meeting, October 19, 1906, was as follows:

T. J. J. SEE, PH.D.: 'The Cause of Earthquakes, Mountain Formation and Kindred Phenomena connected with the Physics of the Earth.'

ERIC DOOLITTLE: 'Problems of Double Star Astronomy.' (With lantern illustrations.)

GEO. M. ROMMEL, B.S.A., AND E. F. PHILLIPS, PH.D.: 'Inheritance in the Female Line of Size of Litter in Poland China Sows.'

THE SOCIETY FOR THE PROMOTION OF AGRICULTURAL SCIENCE.

THE program for the meeting which will be held at Baton Rouge, La., on November 13, is as follows:

9:30 A.M. Meeting of officers and executive committee.

10:30 A.M. Public meeting. (1) 'Importance of Nitrogen as Plant Food,' Professor T. F. Hunt, Cornell University; (2) 'Teaching Agriculture in Public Schools,' Professor S. M. Tracy, Biloxi, Miss.; (3) 'The Growing Importance of Plant Physiology in Agricultural Education,' Dr. Chas. E. Bessey, University of Nebraska; (4) 'The Growing of Alfalfa East of the Mississippi,' Dr. J. E. Beal, Michigan Agricultural College; (5) 'The Problem of Reforesting New England,' Professor F. Wm. Rane, State Forester, Mass.

2:00 P.M. Symposium: Experimental Work. (*a*) 'What is Research?' Professor Thos. F. Hunt, Cornell University; (*b*) 'Tendencies in Station Work as Influenced by the Conception of Scientific Investigation,' Dr. H. J. Wheeler, Rhode Island College; (*c*) 'Scientific Methods in Research,' Dean H. J. Waters, University of Missouri; (*d*) 'The Experiment Stations and the Adams Act,' Dr. C. D. Woods, University of Maine. (*e*) General discussion.

8:00 P.M. Evening meeting. President's Annual Address. Subject: 'The Promotion of Agricultural Science,' Dr. Henry Prentiss Armsby, State College, Pa.

DISCUSSION AND CORRESPONDENCE.

THE SMITHSONIAN INSTITUTION AND RESEARCH.

So much has been said about the advantages of herding scientific workers that a small voice

on the advantages of isolation may not be out of order.

I have read with amazement about the innocuous desuetude into which the Smithsonian Institution is said to have fallen, of its crime of accumulating collections, the lament that

> A national museum has been developed, a new four million-dollar building is now going up for the same; a zoological garden and an astrophysical observatory have been established; finally costly experiments on flying machines have been provided for by congress, all under the management of the secretary of the Smithsonian Institution, who is not an officer of the nation, but elected as executive officer of the Smithson Trust, and paid exclusively from the Smithson fund.

These are, indeed, all serious crimes that are charged to the Smithsonian, and I am afraid that a close search would reveal others, *i. e.*, the organization of the U. S. Fisheries Bureau and the Bureau of Ethnology—perhaps still others. It was doubtless criminal for Langley to experiment with useless flying machines, and, if memory serves me, Henry was equally criminally working with the useless telegraph. Still some of these misdemeanors on the part of the Smithsonian officials seem to have their mitigating circumstances.

Every one ought to know, but, apparently, every one does not, that the truly national institutions of the National Museum, the Fisheries and Ethnological Bureaus, the Geological Survey, have provided the very opportunities for temporary or permanent research on the part of paid investigating curators and of visiting college professors that some one has asked should be provided. These provisions may not be for 'our' narrow little lines of research, but they are for research.

Divorce of the museum idea from the Smithsonian, if this implies the abolition of collections and discouragement of making collections, means the abandonment in biology at least of the fields of research that have in the past been most fruitful in detailed results and broad generalization. The plea seems to me to be not so much for a broad national institution as for the abolition of things that are in favor of the narrow lines in which 'we' are personally interested.

Mr. Hinrichs in his youthful days evidently looked upon Henry as a broad, great man, as I in my youthful days looked upon Baird as a broad, great man, and it comes as a great shock to me to find that my youthful vision was blurred and to read that Baird was only a 'specialist in fishes' and Langley a specialist in stars (and flying machines?). However, we are always inclined to think of the man clamoring for the shoes of some departing worthy as entirely too small in parts to fill them, and the trees we climbed when we were young were much larger than those that grow nowadays.

If we seriously ask ourselves whether the Smithsonian has increased and diffused knowledge among men, I think we must in sorrow admit that indeed it has, and we must, perhaps, even sneakingly honor the men who 'worked' the nation by starting various lines of investigation and then eked out the slender original means of the Smithsonian by gradually relegating these lines of research to independent bureaus of research supported by the nation. Perhaps, as an immigrant I shall not give too great offense by pleading guilty to some little patriotic pride in the collection of bureaus or departments which certainly form a great national institution of research.

The fact that the work in botany, in fishes, in geographical distribution, in geology and geography is done in departments independent of each other ought not to worry a college man, and the fact that the Smithsonian has hounded the departments to their work is not too great a divergence from the aims of Smithson.

The discussion concerning the Smithsonian is a mere trailer to the discussion of the Carnegie Institution to which we treated ourselves some time ago. In our disappointment that the means of the Carnegie Institution are not sufficient to enable us to do all that its establishment caused us to hope for, we turn on the Smithsonian and urge that it must be reformed and, with its much slenderer means, do what the Carnegie Institution found can not be done.

It is possible that the time has come to modify the methods used for 'the increase

and diffusion of knowledge among men.' I am not sure about that, but I have a conviction that it ought not to be turned into a superior club where scientific men may congregate to imbibe the spirit of research, take intellectual stimulants, eliminate their individuality and aberrant ideas and get into the beaten path.

For biology we have a splendid series of laboratories at Woods Hole, Cold Spring Harbor, Dry Tortugas, Beaufort, all of them national in their scope. But the Woods Hole laboratories do not receive the support from investigators that their equipment warrants, and the director of the Tortugas laboratory has recently advocated the abolition of the summer sessions of the universities that the professors who now prefer to teach would, in sheer desperation of *ennui* at nothing else to do, be compelled to conduct research at the splendidly equipped laboratories at the Tortugas.

It is my firm conviction that the middle-aged and older men for whom the advocated central, national, Washingtonian institution would exist, who have not laid out their own paths and are not diligently engaged in clearing and traveling them; who must be sustained by their environment and for whom, therefore, an environment must be created, are not worth any consideration whatsoever.

Segregation has been the most potent factor in organic evolution. Segregation has been and is the most potent factor in developing new ideas in biology. The mass has a regressing, leveling or swamping effect on incipient diverging ideas as well as on diverging variants. Self-sustaining ideas originate as rarely in a crowd without elbow room as self-sustaining mutations in small geographical areas.

Unique faunas are found on isolated islands, in caves or other segregated units of environment. The most pregnant ideas in biology were conceived by Wallace alone in the Malay Archipelago, by de Vries alone at Amsterdam, by Wagner alone in the tropics of America, by Gulich alone in the Sandwich Islands, by Mendel alone in his monastic seclusion and by Darwin flocking by himself at Down.

The astronomers at Arequipa would probably have a more congenial time at Washington, but they would not photograph the southern heavens.

What we need most is not more opportunities for the herding of scientific men, but opportunities for them to work to the best advantage where they are or where their material is to be found. If that happens to be in Washington, by all means let provision be made for them at Washington if it does not already exist, but let us not repeat the mistake made years ago, when it became fashionable to think that all that was worth doing must be done on and by the sea. I have, among others, two good friends in Washington who have confided to me, the one that as soon as the weather permits he leaves Washington, beeause he can do nothing in the swirl that there exists, and the other that when he has a big piece of work on hand he takes his material to one of the universities, because he can do much more there than at Washington.

If the time has come for the Smithsonian to adopt a different method for the 'increase and diffusion of knowledge among men,' I would urge, as I urged when the nascent Carnegie Institution was under discussion, what my own bitter experience leads me to believe is the most urgent need of American science.

My experience no doubt is not at all unique. I too have received liberally from the Smithsonian and its affiliated bureaus whatever publications were issued. This policy of the Smithsonian for the 'diffusion of knowledge' followed by government bureaus has become so liberal that we have protests and suggested reforms of its extravagance. I have been assisted by the loan of books, of valuable museum material and copies of inaccessible fragments of literature. I have reciprocated by sending specimens and preparing reports. I could ask for nothing better along these lines.

Several years ago I set myself to work on the development of the remarkable viviparous fishes of the Pacific coast. I gave all of my time to the collection and working up of the

material in a region at that time thousands of miles from any other embryologist or morphological zoologist. The work could be done nowhere else, but try as I might, not a cent could I secure from anywhere to support me in my work.[1] The result of that work was, aside from smaller papers describing new species, etc.:

1. 'On the Precocious Segregation of the Sex Cells in *Micrometrus aggregatus* Gibbons,' *Journ. Morph.*, V., pp. 480–492, 1 plate.

2. 'The Fishes of San Diego,' *Proc. U. S. Nat. Mus.*, XV., pp. 123–178, 9 plates. Giving spawning seasons and embryology, as well as a list of San Diego fishes.

3. 'On the Viviparous Fishes of the Pacific Coast of North America,' Bull. U. S. Fish Comm. for 1892, pp. 381–478, 27 plates.

4. 'Sex-differentiation in the Viviparous Teleost *Cymatogaster*,' *Arch. f. Entwickelungsm.*, IV., pp. 125–179, 6 plates.

A request for fifty cents a day while working in California was declined by one of the government bureaus. A request for assistance from two other institutions was declined.

The article 'On the Viviparous Fishes' was sold for $100, not quite twice as much as had been paid to draw one of the figures submitted to illustrate it. It is thus that scientific work has been encouraged in the past. The article was a fragment, and the viviparous fishes still await a worker *who must be in the 'field'* among those fishes. Wallace long ago pointed out that individual workers in the field do proportionately vastly more than big, expensive government expeditions. Just as surely vastly more will be accomplished if individual workers are subsidized to do their work where they can do it best than if they are herded at Washington.

The most urgent need is temporary or permanent research professorships: appointments made for specific work of men who will receive their pay from the appointing institution, who are responsible for all of their time and results to the appointing institution, but who carry on their work in their home institution or wherever else their work can be done to best advantage.

CARL H. EIGENMANN.

[1] Thirty odd dollars I spent in incidentally picking up rare or new species of fishes were refunded later.

THE MUTATION THEORY IN ANIMAL EVOLUTION.

THE question of the origin of species is that of the origin of specific characteristics or differential marks. According to one theory they arise gradually by accumulations of the order of fluctuations. According to the other they arise suddenly and completely as mutations. The former theory explains cases in which species are connected by intergrades. The latter best explains discontinuity in species; without it a subsidiary hypothesis to account for observed discontinuity is necessary.

The first reading of de Vries's great work 'Die Mutationstheorie' carried a conviction to the minds of many zoologists as well as botanists that the truth of the discontinuity theory—which has long been urged under other names—had been insufficiently recognized. Of late opposition is appearing and the mutationist is led to reexamine the grounds of his faith. One of the most vigorous of the reactionists is Merriam[1] (1906), who concludes his address before the zoological section of the American Association with the words: "The theory of the origin of species by mutation, therefore, far from being a great principle in biology, as some seem to believe, appears to be one of a hundred minor factors to be considered in rare cases as a possible explanation of the origin of particular species of plants, but, so far as known, not applicable in the case of animals."

The evidence for so sweeping a generalization is to be looked for in the body of the address and I have carefully reread and analyzed his paper. He offers first certain general objections to the mutation theory and then cites cases supporting the alternative theory of gradual modification. His general objections do not seem to me to be important. His query (p. 242) 'if sport variations are less likely to disappear by reversion than are

[1] 'Is Mutation a Factor in the Evolution of the Higher Vertebrates?' SCIENCE, XXIII., No. 581, February 16, 1906.

individual variations' would not have been asked if he had bred sports and observed their resistance to blending and reversion. In poultry, tailless birds bred to tailed birds produce in the second generation and later a large proportion of wholly tailless offspring. Crest, frizzled feathers, tendency to produce pigment in the connective tissue, dominate over the normal conditions. When birds with a down-like modification of the adult plumage are bred together all of the offspring have that peculiarity. Even the polydactile condition does not blend with the normal. After these facts what becomes of the 'opinion' that has been bandied about for over a generation and is resuscitated by Merriam that sports are lost by swamping? Regrettable is Merriam's innuendo directed toward zoologists who have been trained in analytical methods involving the use of the microscope. I am not convinced that analytical training in the laboratory is a less adequate training for tackling the species problem than setting traps and shooting and skinning mammals and birds in the field. What the problem demands is an analysis of species into their constituent *characteristics*, a study of the behavior of these characteristics in the field and the laboratory under controlled environmental conditions and a study of their inheritance.

Certain special cases are cited at some length by Merriam as disproving the mutation theory. The number might have been greatly increased. In general it may be said the widely ranging species of small mammals and non-migratory birds in North America exhibit remarkable parallel changes in coloration, gaining a darker and brighter pigmentation as one passes from the dry plains or the interior deserts to the moister Pacific coast from northern California to Alaska. It is hardly conceivable that mutations of exactly the same sort should affect so many species in the same way. It seems more reasonable to ascribe these changes to climatic conditions. Whether these changes are permanent enough to warrant calling them specific characteristics is uncertain. Mr. Chapman tells me that there is evidence that in the case of certain species originating in the interior, one section spread to the southern deserts, where it became pale, while another section spread northward, where it was rendered dark, and that these two sections have subsequently approached each other on the Pacific coast, where they are strikingly dissimilar, although near together. Such a history, which deserves working out in detail, would indicate a persistence of the climatic modifications. I, for one, am quite satisfied that geographic variation, determined directly or indirectly by climate, is not of the order of mutation and may involve a permanent modification of the germ-plasm. The variation is often sufficient to justify assignment of the extremes to distinct species whenever intergrades are missing. These geographic variations are, however, it must be confessed, largely of a quantitative rather than of a qualitative sort; *i. e.*, usually new characters are not involved, but only a modification of characters, as, *e. g.*, in the case of mammals an increase of the black and red pigment. It may well be that species founded on quantitative differences follow a different method of evolution than those founded on qualitative ones. I, for one, while an adherent of the mutation theory, still maintain the view expressed by me in 1904,[2] when I used some of the same kind of evidence employed by Merriam. This view is that the process of evolution is complex enough to admit of many 'factors' and evolution is not always by mutation.

The real argument for discontinuity in evolution is the occurrence of characteristics in nature that are discontinuous and which never show intergrades. The mere fact of discontinuity between species of the same genus is not sufficient to prove that they have arisen by mutation. It must be shown that the differential characters are in essence discontinuous. The practical way to get at the true nature of characteristics, whether continuous or discontinuous, is by their behavior in inheritance. If, in cross-breeding, a character tends to blend with the dissimilar character of its consort it must be concluded that the character can be fractionized and that

[2] 'Evolution without Mutation,' *Journal of Experimental Zoology*, II., pp. 137–143.

intergrades are possible. If, on the contrary, the characteristic refuses to blend, but comes out of the cross intact, as it went in, the conclusion seems justified that the characteristic is essentially integral and must have arisen completely formed, and hence discontinuously.

Using this criterion, I have of late been testing the application of the mutation theory to animals and have had an opportunity to examine the experiments of others. Some of the work has been done on the characteristics of domesticated 'races,' others on wild varieties. There seems to be no difference in the behavior of characteristics of domesticated and wild varieties. The result is that most characteristics, but not all, fail to blend and are strictly alternative in inheritance. I interpret this to mean that the characteristic depends on a certain molecular condition that does not fractionize. The inference is that if the characteristic is incapable of gradations now it has always been and hence must have arisen without gradations, *i. e.*, discontinuously. Examples of such discontinuous characteristics are the spots on the elytra of certain beetles, the crest on the canary, the form of the comb in poultry, extra toes, black plumage and color of iris. One who sees the striking failure of these characteristics and many others to be modified in any important way will feel convinced that they are not capable of forming intergrades and hence could not have arisen gradually.

While I am not of those who would seem to deny that characters of domesticated species are as *natural* as any others, it is worth inquiring whether discontinuous variations, such as I have been dealing with, occur among feral animals. The evidence is that they do. Thus our gray squirrels exhibit in many localities a striking number of black individuals. These are not found everywhere, but in small areas may be fairly common. Difference in climatic conditions can not account for the blacks—they belong to the order of melanic sports, *i. e.*, mutations. Our red squirrels and various other feral rodents sport in the same way. Birds also show melanic sports, *e. g.*, in the European snipe (*Scolopox gallinago*) a chocolate brown form sometimes appears which, like the black squirrel, has been considered by some as a distinct species. Similarly, more or less albinic sports occur in nature. White crows and blackbirds are well known and many individuals of the house sparrow are partially albinic. The history of the twisted beak of the crossbill (*Loxia curvirostra*) is, of course, unknown. The characteristic is, however, the same as, and has probably had a similar origin with, that which suddenly appears in one per cent. of the poultry that I breed and which has been observed as a sport in crows. Scarcely one of the characteristics of poultry may not be found appertaining to some feral species, and there is every reason to believe that these characteristics have the same property of indivisibility in the latter case as in the former. Such facts as I have cited above could be added to by Dr. Merriam or any other naturalist with a similarly extensive and profound knowledge of the higher vertebrates; and they seem to me to lead to the conclusion that some new characters may arise in nature suddenly, as sports or mutations, and persist as specific characteristics.

Chas. B. Davenport.
Station for Experimental Evolution,
October 18, 1906.

THE RIGIDITY OF THE EARTH.

To the Editor of Science: In Science of September 28 Professor L. M. Hoskins is led to the sad conclusion that I have misunderstood Lord Kelvin's definition of the modulus of rigidity, and he thus apparently questions the results which I have given in *Astronomische Nachrichten*, No. 4,104. Owing to the great length of that paper, my explanation of the connection between rigidity as experimentally determined for solid bodies here upon the earth's surface and other bodies kept rigid by pressure was not sufficiently developed; and as the difficulty that has misled Professor Hoskins appears to have occurred also to others, it seems worth while to point out the omitted steps in the chain of reasoning, which will, I think, make it clear that *my process* has been misunderstood and misinterpreted,

rather than Lord Kelvin's, which has been familiar to me for many years.

1. The error which has arisen in judging my paper proceeds from the habit of dealing with common solids in the laboratory, and the supposition that I am using the same method in dealing with the effective rigidity of the matter within the earth. The question as to how the stresses are applied to a cubical element does not need to be considered, for we are not experimentally shearing or otherwise deforming the elemental cubes of the earth to get the resulting mean rigidity. Inside the limit of pressure which gives the matter the property of an elastic solid, the simple fact is that there is an effective rigidity in spite of the high temperature. Pressure operating through the agency of molecular forces, therefore, is the sole cause of the effective rigidity and I have taken the effective rigidity everywhere proportional to the pressure, which is a perfectly legitimate hypothesis. If others wish to adopt a different hypothesis, they are at liberty to do so. The present hypothesis is satisfactory on theoretical grounds, and apparently confirmed by the numerical calculations given in *Astronomische Nachrichten,* No. 4,104.

2. It may be well to observe that it is a matter of the utmost indifference to me how the elemental cube may be distorted, or whether it be distorted at all. I am not determining coefficients of rigidity for the different elements within the earth. *For my purpose of calculating the earth's mean rigidity, it is sufficient to have something which these rigidity moduluses would be proportional to if they could be determined, and that is the pressure, as calculated from the theory of gravity and Laplace's law of density.*

3. The rigidity of ordinary solids may be expressed in atmospheres; and in dealing with bodies made rigid by pressure, it is convenient to employ the same measure, since this enables us to compare the rigidity of a cold solid to that of a hot body made rigid by confining pressure.

4. There is an old saying that 'facts are stubborn things.' Such, it seems to me, are the numerical results obtained in my paper, by processes of entire mathematical rigor. I calculate that the rigidity of the earth will lie between 750,000 and 1,000,000 atmospheres. In finding this lower limit, the effect of the earth's crust is neglected, and there is, moreover, some slight defect in the gravitational method near the surface even in the case of encrusted bodies. In the case of gaseous bodies, the outermost layers can hardly be regarded as having the properties of an elastic solid, and hence the integration for the mean pressure should stop before we reach the surface. But as we do not know at what depth to stop, I took the mean pressure of the entire planet as giving its most characteristic property.

From these considerations I believe that those who study the paper in *Astronomische Nachrichten,* No. 4,104, will agree that the points raised relate to the experimental determination of moduluses of rigidity, and not to the rigidity of the earth and other planets, which are found by theoretical methods fully explained in the paper itself.

T. J. J. SEE.

U. S. NAVAL OBSERVATORY,
MARE ISLAND, CALIF.,
October 3, 1906.

ANATOMIC NOMENCLATURE: AN OPEN LETTER TO PROFESSOR LLEWELLYS F. BARKER.

Dear Dr. Barker: Through absence from home I have but just received from the publishers your "A Description of the Basle Anatomical Nomenclature [B N A], advance sheets from Dr. Llewellys F. Barker's forthcoming book, 'Anatomical Terminology.'" I rejoice that the subject is to be so fully and ably presented to English-speaking teachers and students of anatomy. Although many of the terms of the [B N A] are not preferred by me, yet—pending the expected eventual general acceptance of my own—I should hail their provisional adoption to the exclusion of their numerous even less worthy synonyms, as enabling me to replace a 'shot-gun policy' by rifle-practise.

I take for granted that the paragraph on page 5 was intended to represent justly my

own share in terminologic discussion. Later I may comment upon certain points, *e. g.*, the alleged 'obscurities of the system' (which —in view of my long preaching and practise of clearness as the first essential of all scientific composition—you must pardon me for regarding as subjective), and the nature and extent of my philologic transgressions (in which connection I may refer to a paper read, by invitation, before the American Philological Association last winter). Now, in view of the fact that all my publications upon the subject either have been sent you or are otherwise accessible, I must express surprise and regret that the foot-note (translated from His) should cite only three of my less extended contributions (two of them privately printed), without mentioning the earlier, the later and the more comprehensive, *e. g.*, the article 'Anatomical Terminology' by S. H. Gage and myself, in the first edition of the 'Reference Handbook of the Medical Sciences,' 1889, our 'Anatomical Technology,' 1882 and 1897, my 'Neural Terms, International and National' (*Journal of Comparative Neurology*, 1896), and 'Some Misapprehensions as to the Simplified Nomenclature of Anatomy' (1898), SCIENCE, April 21, 1899. The several reports of the committees of the Association of American Anatomists, the American Neurological Association and the American Association for the Advancement of Science should have been specified, and it would have been simple justice to name Mrs. Gage, Gerrish, Gould, Huntington, Leidy, the Spitzkas, father and son, and others. Finally, American students should be aware that the subject was definitely brought before the American Association for the Advancement of Science as long ago as 1880, and that a committee of that body was appointed in 1884, three years prior to the date when, as stated by you, 'Germany took the lead.'

In my 'Neural Terms' and 'Some Misapprehensions' I tried to give due credit to earlier simplifiers, Barclay, Owen, Henle, etc. When you and some other anatomists in this country take equal pains to inform yourselves fully as to the facts and principles involved, I believe you will concede that the good and enduring features of the neurologic portion of the [B N A] had been previously adopted or proposed by me, and you will realize that the unprejudiced consideration of the terms preferred by me would have been more advantageous to anatomy and more creditable to yourselves than their premature condemnation.

A copy of this letter will be sent to SCIENCE and *American Medicine*.

Very truly yours,

BURT G. WILDER.

October 11, 1906.

LEFT-HANDEDNESS.

TO THE EDITOR OF SCIENCE: The question of right-handedness has been brought to my notice, and I should like to inquire whether any of your readers has actually counted the number of left-handed men and women in a tribe. Very few implements of savagery are reliable witnesses. The throwing sticks of Eskimo men and the short-handed skin dressers of the women are infallible, since they fit only one hand. In the National Museum, among a great number of throwing sticks—from east Greenland to Sitka, only two are left-handed and both are from the same locality. There is not a left-handed woman's implement in the museum.

O. T. MASON.

October 20, 1906.

SPECIAL ARTICLES.

THE RELATIVE MERITS OF THE 'ELIMINATION' AND 'FIRST SPECIES' METHOD IN FIXING THE TYPES OF GENERA—WITH SPECIAL REFERENCE TO ORNITHOLOGY.

IN attempting to fix the types of any group of genera we shall find that a large number are monotypic, another lot have had their types designated by their authors, a few are fixed by the rule of tautonomy[1] and a certain number are left without any indication of a type—usually complex heterogeneous genera of the older authors. It is these that are always giving us trouble and these alone with which the problem of fixing types is concerned.

It seems to me that it is the duty of those engaged in nomenclatural work to-day to establish our names on as firm a basis as pos-

[1] See SCIENCE, V., No. 16, pp. 114–115, July 18, 1902.

sible, fortified by rules that will leave no chance for personal opinion and subsequent alteration.

With this idea in mind I have given the subject of 'type-fixing' much thought and study, taking for my especial investigation the genera of North American birds, a group which for twenty years has been constantly under the scrutiny of a committee on nomenclature and which has been subjected to about as much changing as any group of genera with which I am acquainted.

As to the merits of the two principal methods of fixing types, my investigations lead me to strongly favor the plan of selecting the first species mentioned.[2]

Its advantages are:

(*a*) Personal opinion is eliminated, two persons can not reach different conclusions.

(*b*) The question is settled independently for each genus, the result does not depend upon the fixing of the type of some other genus.

(*c*) The possibility of change in a generic name rests solely upon the question of priority, and the discovery of an error in the usually accepted date of a publication has no bearing upon the *types* of genera.

(*d*) It is necessary to consult only the original reference to ascertain the type of the genus.

Contrasting with these my objections to the method of 'elimination' as embodied in the A. O. U. Code:

(*a*) It permits the greatest range of personal opinion in the method of its application and the almost endless combinations of principles which it presents.

(*b*) In ascertaining the type of one genus it is often necessary to eliminate one or more others first and an error in one operation affects the others; in fact the genera stand in an interdependent series and a change in the type of one may affect a number of others.

(*c*) The discovery of an error in the date of a publication affects not only the priority of the genera therein described but also every operation of elimination where these genera have been involved; and the types of other genera will be altered simply because the type of one of these genera has been taken out at the wrong date.

(*d*) To ascertain the type by elimination it is necessary to consult every work in which genera have been erected upon any of the included species; also every work where some subsequent author may have specifically selected a type for the genus. It is manifestly impossible to be sure when one has exhausted the latter literature.

Dr. C. W. Stiles's method, as detailed in his paper on 'The Determination of Generic Types,'[3] seems to me to be the perfection of the 'elimination' idea and while better than that, inasmuch as it is more complete and more logical, it is open to objection in even greater degree on account of its necessary complexity.

While I have the greatest admiration for Dr. Stiles's handling of this subject, I can not see how his method can be generally adopted. The systematist can not afford to waste time in studying the application of nineteen rules and recommendations containing thirteen secondary suggestions in fixing the type of a genus. What he must have is simplicity and definiteness. To use a mathematical simile he wants elementary arithmetic rather than calculus.

Now as to the arguments advanced in favor of elimination. It is claimed that:

(*a*) It upholds the work of our predecessors by accepting the genera that they have from year to year separated off from the original composite genus, so that the residue must be what they regarded as the type of the original genus. This argument however, amounts to little or nothing, as in the past many men were working wholly independently of one another and by 'elimination' we inextricably confuse two or more independent lines of work, arriving at results which are probably not in accord

[2] In the case of Linnæan genera I realize that no good can come of enforcing this rule, but we have practical unanimity of opinion on the types of these genera, and I see no reason why we may not accept them arbitrarily just as we accept the genera themselves as our starting point. The A. O. U. Code moreover does not demand consistent elimination for Linnæan names.

[3] Bull. 79, Bureau Anim. Indust., U. S. Dept. Agric.

with either.* Furthermore, many early authors had no conception of a type species and here it seems to me our selection must by any method be an arbitrary one.

(*b*) It is claimed that because we have followed 'elimination' so long in certain groups —as in North American birds, for instance— we should be unwarranted in reversing our method, because it would involve an immense number of changes in generic names which have been fixed by elimination.

This is a serious question and one which I have looked into very carefully. As a test I have consulted the original publication of 391 genera and subgenera of North American birds as given in the A. O. U. Check List, the works in which the other 19 occurred being inaccessible. I find 9 based upon diagnoses without citation of species, while 5 are *nomina nuda* or not used in a generic sense; 173 are monotypic, 59 have their types designated by their authors and 21 are fixed by tautonomy, leaving 124 composite genera with no type stated.

Of these the type as accepted in the A. O. U. Check List is the first species in 92 cases and some other species in 32 cases. Of the latter 16 are Linnæan genera where the type is arbitrarily fixed (see antea), reducing the number that would be changed by adopting the 'first species' rule to 16. In two of these the new type would be congeneric with the old, so that there would be no change in the generic name and three must be changed in any case for reasons of priority. Some of the remainder, however, involve the change of two names each and the total change incident to the adoption of the first species rule would be 10 generic and 4 subgeneric names.

But let us look further. How consistently has elimination been applied? There are 92 genera in which the first species is taken as the type in the A. O. U. Check List, presumably as the result of elimination; but was elimination employed in each case? Let us see.

In 25 cases the original species were all congeneric, and elimination being impossible the first species was selected as the type. In 5 only a partial elimination was possible and the same plan was adopted.

In 21 cases elimination, as I understand it, fixes the type on the first species, as accepted in the Check List, but in 12 cases it fixes it upon some other species. There are also two cases where the tautonomy rule will compel a change and one where the designation of a type by a subsequent author has been overlooked, while 18 are Linnæan genera and 8 I can not decide positively by elimination.

In all 12 generic and 3 subgeneric names will certainly be changed if elimination is consistently applied, and the types of 5 other genera will change but fortunately fall upon congeneric species.

It may be claimed that I did not eliminate properly in all these instances, but in all confusing cases I have followed the practise of Dr. J. A. Allen, who was one of the framers of the code and who has freely and cordially advised me in this matter.

It will be seen from the above that far from causing an overturning of our ornithological nomenclature the adoption of the first species rule will cause less change than our adherence to elimination.

As a further test I have examined the bird genera of the world from 1758 to 1820, comprising 513 names exclusive of Linnæus. Of these 282 are monotypic, 94 have their types fixed by tautonomy, 18 are based upon diagnoses only, leaving 119 composite genera in which no type is indicated. The selected type, according to the British Museum Catalogue, is the first species in 102 cases and some other species in 17 cases.* The task of working out the results by elimination I have not ventured to attempt.

It remains now to show the various ways in which 'elimination' is applied in practise. For this purpose I prepared the following series of questions which were intended to cover the elementary principles of elimination:

Question I.

Genus A, 1850.
Species 1 = type of *B* 1860.
2 = type of *C* 1870.
3 = type of *D* 1880.

* In these the action is usually arbitrary, seldom or never the result of 'elimination.'

Genus X, 1850.
Species 4 = type of *Y* 1810.
5 = type of *Z* 1820.
6 = type of *W* 1860.
Is not 3 the type of *A* and 6 the type of *X*?

Question II.

Genus A, 1800.
Species 1 = type of *B* 1810.
2 belongs to *B* (according to our present views).
3 = type of *C* 1820.
Which is the type of *A*, species 2 or 3?

Question III.

Genus A, 1760.
Species 1 = type of *B* 1770.
2 belongs to *C* 1780 (the type of *C* is another species not included in *A*).
3 = type of *D* 1790.
Which is the type of *A*, species 2 or 3?

Question IV.

Genus A, 1850.
Species 1 = type of *B* 1860.
2 = type of *C* 1870.
3 = type of *D* 1880.
1. In our opinion to-day *D* is a synonym of another genus *E*, 1855. Do we consider species 3 removed from *A* at 1855 or 1880?
2. Suppose we consider *D* a synonym of *B*. Is species 3 then removed at 1860 or 1880?

Question V.

Genus A, 1800.
Species 1 = type of *B* 1810.
2 = type of *C* 1820.
3 = type of *D* 1830.
4 = type of *E* 1840.
1. Suppose we regard *E* as a synonym of *C* and consider both 2 and 4 removed at 1820, then is not 3 the type of *A*?
2. Suppose we regard *C* and *E* as distinct genera, then is not 4 the type of *A*?
3. Now if an author adopting the first view makes 3 the type of *A*, must a subsequent author holding the second view adopt 3 or may he change the type of *A* to 4?

Question VI.

When a reviser explicitly selects a type for an early composite genus must he take a species that has never up to that time been removed from that genus as the basis of a new one, or is his action binding, no matter what species he may select so long as it is one of the originally included species?

Question VII.

Genus A, 1800.
Species 1 = type of *C* 1804.
2 = type of *D* 1806.
4 = type of *F* 1805.
Genus B, 1802.
Species 1 = type of *C* 1804.
2 = type of *D* 1806.
3 = type of *E* 1808.
Two genera erected independently for nearly the same species. In eliminating *A* genus B must be considered, since 1 and 2 are contained in it, but we can not ascertain the type of *B* until we know the type of *A*. How can such cases be treated?

Question VIII.

Genus A, 1800.
Species 1 = type of *C* 1820.
2 = type of *D* 1825.
3 = type of *E* 1830.
Genus F, 1840.
Species 1 = type of *C* 1820.
2 = type of *D* 1825.
3 = { type of *E* 1830. / type of *A* 1800.
4 = type of *B* 1810.
Two genera established for nearly the same species. Is not 3 the type of *A*? If so what is the type of *F*?

These were submitted to the following twenty-five systematic zoologists and botanists:

Vertebrate Zoologists.—J. A. Allen, B. W. Evermann, Theodore Gill, O. P. Hay,* H. W. Henshaw, D. S. Jordan, C. Hart Merriam, G. S. Miller, Jr.,* H. C. Oberholser, W. H. Osgood, T. S. Palmer, C. W. Richmond, Robt. Ridgway, Leonhard Stejneger,* Witmer Stone.

Invertebrate Zoologists.—T. D. A. Cockerell, W. H. Dall, L. O. Howard,* H. A. Pilsbry, Mary J. Rathbun, C. W. Stiles.

Botanists.—J. H. Barnhart, N. L. Britton, O. F. Cook, F. V. Coville.

Replies were received from all but those marked with an asterisk, and for these answers I desire to express my thanks. All of the botanists and Professor Cockerell believe in

adopting the first species as the type and, therefore, not being accustomed to use elimination, declined to attempt to answer the questions. Dr. Jordan and some others also adopt the first species rule, but, having used elimination at one time or another, answered according to their interpretation of this method.

Dr. Stiles adopts his method of exclusion; and Drs. Gill, Palmer and Evermann believe that further knowledge of individual cases would necessitate different answers from those they have given, a view which to my mind makes a hard and fast rule impossible and opens the door wider than ever to individual opinion.

A summary of the answers follows:

Question I.

13 answer yes to both.
1 answers yes to (*a*), no to (*b*).
1 answers yes, 'with reservations.'
1 'depends on further history.'

Question II.

10 answer sp. 3.
4 answer sp. 2.
1 answers sp. 1.
1 'depends on further history.'

Question III.

9 answer sp. 3.
5 answer sp. 2.
1 answers sp. 1.
1 'depends on history.'

Question IV.

(*a*)

7 say 1855.
8 say 1880.
1 says date when synonymy was first recognized.

(*b*)

8 say 1860.
6 say 1880.
2 say 'depends on history.'

Question V.

(*a*)

12 say yes (4 with reservations).
3 say no.
1 'depends.'

(*b*)

15 say yes.
1 'depends.'

(*c*)

5 say change.
8 say no change.
3 in doubt.

Question VI.

14 say yes.
1 says no.
1 'not necessarily.'

Question VII.

(*A*)

8 say sp. 2.
5 say sp. 4.
2 in doubt.
1 $A = B$ absolutely.

(*B*)

14 say sp. 3.
1 in doubt.

Question VIII.

(*A*)

15 say type $A = 3$.
1 says $A = F$ absolutely.

(*B*)

4 say sp. 4.
2 say sp. 2.
4 say sp. 3.
1 says 1, 2, 3 or 4.
1 says ?
3 say F has no standing.

These questions were purposely made as simple as possible in order not to involve two or more principles in one example, but the cases encountered in actual practise are usually far more complicated; the diversity of opinion upon them can readily be imagined.

The points that I have tried to bring out in this discussion are:

(*a*) That 'elimination' even in the best hands will not give uniform results and that any attempt to formulate minute rules for its application will create a system too complicated for general use.

(*b*) That if elimination be uniformly applied to all complex genera, our nomenclature will undergo more changes than if the 'first species' rule be adopted. I have, I think, proved this so far as ornithology is concerned, and I have no doubt the same conditions will be found to prevail in other branches. Elimination has never been practised in Europe and does not seem to be understood by foreign

writers, and in the vast majority of cases the first species is taken by them as the type. In nearly every case where the A. O. U. Check List and the British Museum Catalogue differ in the selection of a type species for an ornithological genus, the adoption of the first species by the Americans will bring them into accord.

(*c*) That we have in the 'first species rule' a method that can lead to but one result and can be practised by any one, and by which the type of a genus can be ascertained at once by consulting one reference, instead of involving the examination of many works and the expenditure of much time and thought.

WITMER STONE.

ACADEMY OF NATURAL SCIENCES, PHILADELPHIA.

GENERIC NAMES OF MERYCOIDODONTS.

As there has been no recent thorough revision of the *Merycoidodonts* (*Oreodonts auctorum*), based upon an examination and comparison of all the types, there has been much confusion and error in the use of nearly all of the generic names. Many new forms have recently been discovered, and investigation has been greatly retarded by uncertainty as to where many of these should be placed. By the kindness of those who are in charge of the various museums which contain the types of the genera, the writer has had the opportunity of examining all of the older types, and he here gives his conclusions concerning the various names which have been used.

MERYCOIDODON Leidy.

Type *Merycoidodon culbertsoni* Leidy. Proceedings Academy Natural Sciences, Philadelphia, Vol. IV., 1848, p. 47, Plate.

Synonyms: *Oreodon culbertsoni* (Leidy), *O. priscum* Leidy, *Cotylops speciosa* Leidy.

The type is a portion of the upper jaw with the last two molars, and a fragment of the mandible with all the lower molars. The outer cusps of the second upper molar, and the heel of the last lower molar are gone. The type was sent from the Bad Lands of Dakota by Mr. T. Culbertson and is now the property of the Academy of Natural Sciences in Philadelphia. The two specimens probably belong to the same individual, as the last molar in both jaws is in about the same stage of eruption. These molars, though fully formed, had not yet attained the level of the other teeth, but they are well exposed, so that their structure can be easily seen.

Dr. O. P. Hay (SCIENCE, Vol. IX., April 21, 1899, p. 593, and 'Catalogue of the Fossil Vertebrates of North America,' p. 665) has reinstated the original name *Merycoidodon* in the place of *Oreodon*, which had come into universal use. He says that *Merycoidodon* clearly has priority over both *Oreodon* and *Cotylops*. There is a close similarity in the teeth of the Middle Oligocene *Merycoidodonts*, and it seemed best, at least until the type should be found and its identity with '*Oreodon*' demonstrated, to use the commonly accepted name; but now, after having examined the type and compared it with various specimens of so-called *Oreodon culbertsoni*, I believe that the original name should be used for the following reasons:

1. The type specimen was fully described by Leidy and figures were published, which, though not clear enough, perhaps, to distinguish *Merycoidodon* from specimens of closely allied genera, leave no doubt as to the identity of the type specimen.

2. The name *Cotylops* was given to a young individual with the milk dentition. The type of *Oreodon* was the 'greater portion of a cranium' with teeth in a very much mutilated condition, sent to Dr. Leidy by Dr. Hiram Prout, of St. Louis. (Proceedings Academy Natural Sciences of Philadelphia, Vol. V., p. 237.)

3. This type appears to be lost, but Dr. Leidy, who was a careful observer, had the types of *Merycoidodon*, *Oreodon* and *Cotylops* all before him and he said that the true molars of *Oreodon* had exactly the same form and very nearly the same size as the posterior two molars of *Merycoidodon*. He afterwards concluded that these genera belonged to the same species.

4. So far as the present writer has observed there are differences, though not great, which separate *Merycoidodon* from nearly related

genera, so that, as a rule, *Merycoidodon* can be distinguished by the teeth alone.

EUCROTAPHUS Leidy.

Proceedings Academy of Natural Sciences, Philadelphia, Vol. V., 1850, p. 90.

Type *Eucrotaphus jacksoni* Leidy.

The type specimen is the posterior portion of a skull in the Academy of Natural Sciences in Philadelphia. According to the label it comes from near Fort Laramie, Wyoming, and was presented by Alexander Culbertson. The type specimen is distinguishable from *Eporeodon* by peculiarities in the basal portion of the skull; and, so far as I have observed, the more complete specimens with large bullæ from the region of the plains are different from those of Oregon; therefore it seems best at present to consider them as belonging to separate genera. In the type of *Eucrotaphus* the tympanic bulla is large and symmetrically rounded, the paroccipital process is intermediate between that of *Merycoidodon* and *Eporedon,* being more transverse and laterally expanded at the base than in the former and less than in the latter. There is no lamina of bones separating the pit for the tympanohyal from the stylomastoid foramen as in *Merycoidodon.* The external auditory meatus is trumpet-shaped and not greatly enlarged as in *Eporeodon.*

EPOREODON Marsh.

American Journal Science (3), IX., 1873, p. 249.

Type *Eporeodon occidentalis* Marsh.

A skull from John Day River, Oregon. Presented to the Yale Museum by Rev. Thomas Condon.

Marsh evidently failed to mark the type, but only one skull in the Condon collection corresponds to the type as Marsh designated it. The bullæ are inflated. The paroccipital processes are transverse and moderately expanded laterally and are not so prismatic behind the bullæ as in *Eucrotaphus.* The two genera are readily distinguishable by the forms of the external portions of the tympanics. In *Eporeodon* the external auditory meatus occupies a large space between the postglenoid and paroccipital processes. There is a deep pit for the tympanohyal and it is so placed that it looks almost like an inner opening to the external meatus. There is no pit for the mastoid foramen. The outer portion of the external auditory meatus is expanded anteriorly into a wing in other specimens of *Eporeodon,* and I think it is also thus expanded in the type, though my notes do not state the fact. Most of the John Day skulls are flattened on top and the upper contour of the skull is nearly straight. This usually serves at a glance to separate *Eporeodon* from *Eucrotaphus,* but occasionally there is a skull from the John Day formation more like those of *Eucrotaphus.*

MESOREODON Scott.

Type *Mesoreodon chelonyx* Scott, American Naturalist, Vol. XXVII., 1893, p. 661.

The type, which is contained in the Princeton Museum, is a skull and mandible with a large portion of the skeleton. It was obtained in the lower Deep River (Fort Logan) beds in Smith River valley in Montana. The skull is still partially enclosed in a hard matrix, so that some of the characters, which distinguish the previously mentioned genera, can not be clearly made out in this specimen. The skull is rather high, not depressed vertically as in *Eporeodon.* The teeth are not high, but according to Scott the molars show 'an incipient tendency to hypsodontism.' The paroccipital processes are expanded laterally above, are prismatic below and are in contact with the tympanic bullæ anteriorly. The external and auditory meatus is long, straight, directed upward as well as outward and backward, and has anterior wings in contact with the postglenoid processes. It probably can be distinguished from *Eporeodon* by its larger size, higher skull, the different form of the squamosal processes of the zygoma, and the different form of the tympanics.

PROMERYCOCHŒRUS Douglass.

Type *Promerycochœrus superbus* Leidy, American Journal of Science, January, 1901, p. 82.

From the upper John Day beds, Oregon.

The type is the property of the Rev. Thomas Condon, who loaned it to the Yale Museum. It consists of the greater portion of a skull, from which the matrix has not been fully removed. The specimen was first described as *Oreodon* by Leidy, but was afterward assigned to the genus *Merycochœrus* by Bettany. After the discovery of more complete remains of *Merycochœrus* it was seen by Matthew and Douglass that the specimens from the John Day were very different, and the latter gave them the name *Promerycochœrus,* making *P. superbus* the type. The skull is large and elongated. The upper contour is nearly straight, the squamosal portions of the zygomatic arches are enlarged. The occiput is not high, and the tympanic bullæ are large and elliptical.

Merycoidodon, Eucrotaphus, Eporeodon, Mesoreodon and *Promerycochœrus* appear to be quite closely related, and, when more is known of them, it may be found difficult to generically differentiate some of them, yet it is undoubtedly better to keep them separate at present. Their near relationship seems to be confirmed by the characters of the feet and other portions of the skeleton. *Merychyus, Ticholeptus* and *Merycochœrus* are apparently more distantly related to the foregoing and to each other.

MERYCHYUS Leidy.

Type *Merychyus elegans* Leidy. Proceedings Academy Natural Sciences, Philadelphia, 1858, p. 24.

From the Miocene of the Niobrara Valley, Nebraska. The type consists of portions of maxillaries and a mandible with teeth, and is preserved in the Academy of Natural Sciences in Philadelphia. Size rather small, not larger than *Eporeodon.* Premolar shorter than the molar series, upper premolars inclined backward. From associated specimens in the American Museum of Natural History and the Carnegie Museum it appears that the skull of *Merychyus* is low, and limbs and feet long and slender.

TICHOLEPTUS Cope.

Type *Ticholeptus zygomaticus* Cope. American Naturalist, XII., 1878, p. 129.

From the Ticholeptus (Deep River) beds of Smith River Valley, Montana. The type specimen consists of the greater portion of a skull with a mandible, preserved in the American Museum of Natural History. The skull is considerably crushed and still partly imbedded in the matrix. It is short and high, and the teeth moderately hypsodont. The premolars are crowded, but not reduced in size. There are small prelachrymal vacuities. Dr. Matthews and myself have each discovered, in Montana, skulls and parts of skeletons which we have assigned to this genus, but they are somewhat different, and one has longer limbs and feet than the other. It is very certain, as Dr. Matthews told me orally several years ago, that *Ticholeptus* is a valid genus, for the discovery of more complete specimens of *Merychyus* shows that the latter is a quite different animal.

MERYCOCHŒRUS Leidy.

Type *Merycochœrus proprius* Leidy. Proceedings Academy Natural Sciences, Philadelphia, 1858, p. 24.

The material consists of portions of a maxillary and a mandible with teeth from the Miocene red-grit bed near Fort Laramie, Wyoming, and is now in the Academy of Natural Sciences in Philadelphia. The skull, especially the posterior portion, is broad and low; the basicranial axis forms a considerable angle with the plane of the palate. The nasals are shortened, and the animal undoubtedly possessed a long nose, or proboscis. The teeth are hypsodont, the premolar is considerably shorter than the molar series, and the molars increase rapidly in length and height posteriorly. From this genus must be excluded the so-called *Merycochœrus laticeps* Douglass and *M. altiramus* Douglass from Montana, which are still more specialized than the type of *Merycochœrus,* the former of which has been assigned by the writer to a new genus which will shortly be published.

EARL S. DOUGLASS.

CARNEGIE MUSEUM,
October 15, 1906.

ORIGIN OF THE DEPRESSION KNOWN AS MONTEZUMA'S WELL, ARIZONA.

THE singular bowl-shaped depression known as Montezuma's Well on Beaver Creek, Yavapai County, Arizona, is one of the noted natural wonders of that territory. It is frequently visited by tourists and others who get so far into the interior of Arizona as Camp Verde, from which the well is twelve miles distant. Hinton in his 'Handbook of Arizona' (1878) gives a fair representation, by a wood-cut, of one side of the well.

The depression is in the midst of a nearly level area; it is nearly circular, 500 to 600 feet in diameter, with vertical walls, or sides, from 30 to 40 feet downwards to the head of a talus slope extending to a circular pool of water, said to be of unfathomable depth.

The popular theory of the origin of this cavity and well in the plain is that it is volcanic; a crater, like a pit-crater. While there is a resemblance in form to a pit-crater there is no other point of resemblance. There are no volcanic rocks or traces of lava, except numerous broken metaltes left by the ancient cliff-dwellers who once dwelt in the cavernous spaces in the limestone walls around the pool. The water is not stagnant, it flows out by a subterranean channel to the adjoining valley of Beaver Creek, from which, probably, the supply is received at some more remote point above.

This depression is evidently the result of caving-in, a falling down, of the roof of a cavern formed by running water in the nearly horizontal limestone strata. Most of the débris of the former roof which was engulfed in the cavern has no doubt been largely dissolved and washed away by the flowing water.

The existence of once inhabited rooms, or chambers, around the well in the overhanging limestone cliffs, and also of extensive ruins of stone buildings above, around the borders of the depression, confirms the other evidences of the great antiquity of the well.

There are other peculiar basin-shaped depressions in the general surface in the vicinity of Flagstaff and Walnut Creek in Coconino County whose origin may be similarly explained or, perhaps, referred to the solvent action of surface waters sinking or percolating downwards through calcareous strata to some subterranean channel, or by subterranean streams.

The peculiar depressions in the soil of the lead and zinc region of Wisconsin, often seen at intervals along certain lines upon the surface, may be similarly accounted for. They indicate the downward flow of solvent waters to and along the 'crevices' in the horizontal limestones and thus are indicative of lodes or of ore to the miners.

The foregoing described phenomena suggest that the remarkable crater-like cavity known as 'Coon Butte Crater' may have similarly originated. This suggestion is made with some reluctance, inasmuch as I have not studied the locality. But it seems as if all the conditions so well and fully described by Mr. D. M. Barringer, and Mr. Tilghman, in their memoirs (*Proceedings of the Academy of Natural Sciences of Philadelphia*, December, 1905) may be explained upon the hypothesis of a sink or downward flow of surface (meteoric) water carrying away by solution the lime of the calcareous sandstone, reducing its volume, or forming cavernous spaces, which permitted the upper unsupported beds to fall in. Such solvent action would leave the silica of the calcareous sandstone in a divided pulverulent condition, much as it is found, with here and there portions with less lime or less decomposition. The subsidence of the area would carry down with it any meteoric fragments which were on the surface or in the soil, and to considerable depths.

The numerous masses of iron oxide or 'magnetite,' as described, are doubtless the residual fragments of siderolites originally highly charged with nodules of sulphides and phosphides, and probably with chlorine. The continuous oxidation and exfoliation of some meteorites, even when protected from the elements in museums, are familiar examples.

WM. P. BLAKE.

QUOTATIONS.

THE HUXLEY LECTURE.

PROFESSOR IVAN PETROVITCH PAWLOW, the celebrated professor of physiology at the Uni-

versity of St. Petersburg, delivered the Huxley lecture at Charing Cross Hospital on October 1. The function took place in the out-patient hall of the hospital, which was crowded with an enthusiastic audience. The professor was welcomed on his arrival in a small room adjoining the hall by an informal reception committee, consisting of Lord Kilmorey (chairman of the hospital), Sir A. Rücker, Professor Starling, Dr. Pavy, Professor Gotch, Dr. W. V. Bayliss, Dr. Mott, Mr. Waterhouse and Dr. Bosanquet. When Professor Pawlow was conducted into the hall by Lord Kilmorey, the reception accorded to the eminent physiologist was so hearty that it seemed to take him by surprise. In a few words Lord Kilmorey introduced the lecturer to the audience, and Professor Pawlow then proceeded to deliver his address. He spoke in German, and took for his subject the scientific investigation of the psychical faculties or processes in the higher animals. At the conclusion of the address Sir A. Rücker, principal of the University of London, moved a vote of thanks to Professor Pawlow. He assured him that the interest in his address was not confined to the walls of Charing Cross Hospital, but the University of London as a whole was delighted to welcome so distinguished a representative of Russian science. Professor Starling, in seconding the vote of thanks, said that the address bore out the old statement as to the close connection that existed between the advance of science and the advance of methods at the disposal of scientific investigators. Great strides had been made in the science of physiology by the introduction of anesthetics which had abolished pain from the physiological laboratory. The use of anesthetics necessitated the introduction of abnormal conditions into an experiment, but Professor Pawlow had now taught them how to experiment on the living animal in perfect physiological condition without pain, without anesthetics, and without even discomfort. Lord Kilmorey formally expressed the thanks of the meeting to Professor Pawlow, who replied in a few words suitably acknowledging the compliment.—*The British Medical Journal.*

ASTRONOMICAL NOTES.

THE POTSDAM PHOTOMETRIC DURCHMUSTERUNG.

VOLUME XVI. of the *Publikationen des Astrophysikalischen Observatoriums zu Potsdam* has just been issued. It contains the fourth and last zone of the photometric Durchmusterung, which has been carried on by Müller and Kempf during the last twenty years, of which the first volume appeared in 1894. It includes all stars in the northern heavens of the magnitude 7.5, and brighter, and forms a most important addition to the photometry of the stars.

Although the great discordance among the various estimates of brightness made some sort of exact measurements a necessary step in the advancement of astronomy, but little progress had been made until a quarter of a century ago. The first volume of the Harvard photometry, begun in 1879, was published in 1884, and the Uranometria Oxoniensis appeared in 1885.

The Durchmusterung of Müller and Kempf comes opportunely, since it gives measurements of great precision, and throws light on the results obtained by earlier observers. It is of the greatest importance, not only to reduce the accidental errors as much as possible, a result which has probably been accomplished by Müller and Kempf, but, especially, to show whether the systematic errors, which are inseparable from such investigations, are so small as to make the results trustworthy.

The work of Pritchard at Oxford was carried on with a wedge photometer; that of Pickering at Harvard with polarization photometers in which a polar star is compared directly with all the stars whose magnitudes are to be determined; the observations of Müller and Kempf have been made with photometers of the Zöllner type, in which, by means of an artificial star, the stars to be measured are compared indirectly with various well-distributed standard stars whose magnitudes have been determined with all possible care.

The work of the Potsdam astronomers was arranged in four zones extending from the equator to the north pole of the sky. The

authors take advantage of the completion of the last zone to make a discussion of their results, and a comparison between them and the determinations of other astronomers, a brief synopsis of which follows.

Systematic Differences in the Potsdam Observations.—Small systematic differences appear between the two observers, and between the photometers which they employed. For a mean interval of 0.43 magnitude the mean difference in brightness of two stars, with photometer C1, is smaller by 0.02 when measured by M than by K. With photometer D a difference of 0.01 was found for a measured interval of 0.28.

Differences also appear between the observations of the fundamental stars and those of the zones. Taking all four zones together a mean difference of 0.49 magnitude was measured less by 0.030 in the zone observations than in those of the fundamental stars, when photometer C1 was used, and less by 0.007 for photometer D. On the assumption that this quantity increases according to the measured difference, this corresponds to a difference of 0.061 for a full magnitude for photometer C1, and to 0.018 for D. The latter instrument apparently gives results of slightly greater precision. A comparison of the different photometers also shows small differences for both magnitude and color.

For the determination of the differences between M and K, as affected by magnitude and color, a discussion is given of all except the fundamental stars. They are placed in four groups, white, yellowish white, whitish yellow, yellow and deeper shades. For all, $M - K = -0.03$ magnitude. This result agrees well with that of the third zone, but is somewhat at variance with that of the first zone, where the difference was $+0.02$. In the estimation of color intensities no significant differences appear.

The precision attained is indicated by a comparison of the measurements of 2,485 stars, which were observed by both M and K. These give a mean difference between the observers of ± 0.11 magn. The probable error of a single observation is ± 0.052, and for a catalogue value based on two evenings' observations, ± 0.037. There seem to be no marked differences in these values as influenced by magnitude or color.

Comparison between the Potsdam Measurements and the Bonn Estimates.—The comparison with the estimated magnitudes of the Bonn Durchmusterung (BD) presents some curious features. For naked-eye stars of all colors, a magnitude by the BD corresponds to 0.9035 of the Potsdam scale, while for the fainter stars the corresponding value is 1.0566. The logarithms of these quantities are 0.361 and 0.423. The corresponding values for the three preceding zones were 0.329, 0.362, 0.366 for bright stars and 0.400, 0.457, 0.484 for faint stars. The variations in these quantities seem pretty large.

When taken with respect to color, the difference, Potsdam — BD, decreases systematically from $+0.41$ for white stars to -0.01 for yellow stars. This difference, Potsdam — BD, shows also a marked but systematic variation according to the declination of the stars. This, however, might perhaps be explained by a large atmospheric absorption at Bonn, for which no correction was applied.

Comparison between the Determinations at Potsdam, Harvard and Oxford.—The Harvard values used are those of volumes XIV. and XXIV. These are referred to as Pickering I. and Pickering II. Later volumes of the Harvard photometry will be discussed at another time. Tables are given showing the systematic mean differences, Potsdam — P I., Potsdam — P II. and Potsdam — Pr (Oxford), for the zone in question, and a special table giving the individual cases in which the differences amount to half a magnitude, or more. The number of such cases is small, one for P I. and five for P II. and Pr. This number is less than in preceding parts of the work, which is explained by the authors as due to the fact that both at Harvard and at Oxford the pole-star was the standard of comparison, and that errors would naturally be fewer in this zone, 60°–90°, which lies near the pole-star.

These tables are followed by others giving the results for all four zones combined. Since the systematic differences are practically the same for all four zones, an inspection of the

final means will be sufficient. These differences can best be shown by the following brief table:

	Potsdam—B D.	Potsdam—P I.	Potsdam—P II.	Potsdam—Pr.	Means.
White	+0.25	+0.29	+0.29	+0.23	+0.26
Yellow white	+0.26	+0.25	+0.21	+0.20	+0.23
White yellow	+0.11	+0.09	+0.02	+0.06	+0.07
Yellow, etc.	—0.05	—0.04	—0.09	—0.07	—0.06

The most striking feature shown in this table is the remarkable accordance in the mean results at Bonn, Harvard and Oxford. In each case there is a positive difference of about a quarter of a magnitude for white stars, and this quantity diminishes systematically to a small negative value for the yellow-red red stars. The systematic differences between the Bonn, Harvard and Oxford catalogues are inappreciable. In all cases Potsdam makes the white stars fainter and the red stars brighter than the other three observatories. Between these two extremes, however, somewhere between the whitish-yellow and yellow stars, the differences disappear. The differences seem difficult of explanation. On the one hand, we have Potsdam with two observers and with Zöllner photometers, and on the other hand, Bonn, Harvard and Oxford, with eight observers and photometers of several kinds. The differences concerned are small, however, and it may well be regarded as remarkable that the color scale of the different catalogues should agree so closely that for stars of one color the differences are positive, and for those of another color, negative.

Another relation is shown by arranging the observations with regard to magnitude. We may use for illustration Potsdam — P I. It is thus found that the scale of magnitude of the Harvard photometry lies, for stars of different color, on both sides of that of the Potsdam scale. For white stars a full Harvard magnitude equals about 1.05 of the Potsdam scale; for yellowish-white, 1.03; for whitish-yellow, 1.01; and for yellow and red stars, 0.94; and for all, about 1.00. Taking into consideration the systematic differences which are found in the results of a single observatory by different observers and instruments, as shown in the present discussion for Potsdam, and also the known influence of the Purkinje phenomenon, the differences of scale between Potsdam and Harvard are surprisingly small.

SOLON I. BAILEY.
HARVARD COLLEGE OBSERVATORY.

BOTANICAL NOTES.

BOTANY IN THE ST. LOUIS CONGRESS OF 1904.

A LITTLE more than two years ago in the Congress of Arts and Science of the Universal Exposition at St. Louis a considerable number of botanical papers were read which are now given wider publicity by being printed in the fifth volume of the published proceedings of that notable meeting. The following papers on botanical subjects are printed in this volume: 'Development of Morphological Conceptions,' by Professor John M. Coulter; 'A Comparison between Natural and Artificial Selection,' by Professor Hugo de Vries; 'Plant Morphology,' by Professor Frederick O. Bower; 'The Fundamental Problems of Present-day Plant Morphology,' by Professor Karl F. Goebel; 'The Development of Plant Physiology under the Influence of the Other Sciences,' by Professor Julius Wiesner; 'Plant Physiology—Present Problems,' by Professor Benjamin M. Duggar; 'The History and Scope of Plant Pathology,' by Professor Joseph C. Arthur; 'Vegetable Pathology, an Economic Science,' by Merton B. Waite; 'The Position of Ecology in Modern Science,' by Professor Oscar Drude; 'The Problems of Ecology,' by Professor Benjamin L. Robinson; 'Relations of Bacteriology to Other Sciences,' by Professor Edwin O. Jordan; 'Some Problems in the Life-history of Pathogenic Microorganisms,' by Professor Theobald Smith. To these may be added the two more general papers—'The Recent Development of Biology,' by Professor Jacques Loeb, and 'The Problem of the Origin of Species,' by Professor Charles O. Whitman, and the brief introductory addresses by Professor Charles R. Barnes (plant physiology) and Professor Charles E. Bessey (plant pathology). Nor are these all that will

prove of much direct interest to the scientific botanist, who will find much that he can apply to his own science in Professor Charles B. Davenport's 'Animal Morphology in its Relation to Other Sciences,' Professor Alfred M. Giard's 'Present Tendencies of Morphology and its Relations to the Other Sciences,' Professor Oskar Hertwig's 'Advances and Problems in the Study of Generation and Inheritance,' Professor William K. Brooks's 'Individual Development and Ancestral Development,' Professor William E. Ritter's 'Place of Comparative Anatomy in General Biology' and Professor Yves Delage's 'Comparative Anatomy and the Foundations of Morphology.'

These stately volumes are issued by Houghton, Mifflin & Company, which is a sufficient guarantee of their excellence in type, paper and presswork.

TWO AND THREE PISTILS IN CASSIA CHAMAECRISTA.

In the autumn of 1905 I chanced to find a single flower of *Cassia chamaecrista* with two pistils (carpels), one of normal size and the other much smaller, so small in fact that its ovules had not developed. A few days later while out with a party of students I directed their attention to what I had found, and suggested that they hunt for similar cases of two pistils in a flower. It proved not to be a difficult task to find such cases, and in most of those found, both pistils were of normal size. A considerable number of these twinned pistils were secured, and preserved for further examination. They appeared to be normal in every particular. I was especially interested in the discovery of two cases in which there were *three* pistils in each flower. In one of these cases the three pistils were of approximately equal size.

If we are right in thinking that the *Caesalpiniaceae* have probably been derived from *Rosaceae* by a reduction in the number of carpels (along with other floral modifications) we have in these cases of two and three carpels a reversion to the polycarpellary type. It became interesting to know whether these cases were sporadic, or whether there was a tendency in these plants to produce more than one carpel. Accordingly, I visited this year the station where we found the two- and three-carpelled flowers last year, and again found a considerable number of flowers with two carpels. None was found with three carpels, though this may have been due to the fact that the search was not as prolonged as last year. It is evident, however, that in this particular colony of these plants there appears to be a tendency to produce bicarpellary flowers.

ENGLER'S PFLANZENREICH.

The twenty-third and twenty-fourth *Heften* of Engler's 'Pflanzenreich' are devoted respectively to the *Halorrhagaceae* (by A. K. Schindler) and the *Aponogetonaceae* (by K. Krause). In the treatment of the first, the author excludes *Hippuris*, usually included in this family, regarding it as more nearly related to the *Santalaceae*. Seven genera are retained, viz., *Loudonia* (with 3 Australian species); *Halorrhagis* (59 species, mostly Australian); *Meziella* (1 Australian species); *Laurembergia* (18 species, from New Zealand and Australia to tropical Asia, Africa and America); *Proserpinaca* (2 North American species); *Myriophyllum* (a cosmopolitan genus of 36 species); *Gunnera* (33 species from Africa to New Zealand). The second family (*Aponogetonaceae*) is a small one containing but one genus (*Aponogeton*), which includes 22 species ranging from Southern Africa to tropical Asia and North Australia. In both *Heften* the numerous illustrations are excellent.

Charles E. Bessey.
The University of Nebraska.

CHEMICAL ABSTRACTS.

A year ago an effort was made to secure the cooperation of the London Chemical Society, the Society of Chemical Industry and the American Chemical Society in the publication of an abstract journal which should cover the whole field of chemistry and which should go to the members of each society. A plan for such a cooperation was carefully worked out and submitted to the two English societies, but the Society of Chemical Industry finally decided that it was impossible for them to take part in such a cooperative enterprise.

The American Chemical Society has now reached a membership of more than three thousand, and after a careful consideration of the questions involved the council of the society has decided that a set of abstracts should be furnished to the members of the society in the same manner that this is done by the other large chemical societies. The society has accordingly undertaken the publication of such abstracts in the form of a separate journal, which will appear under the name *Chemical Abstracts,* beginning with January 1, 1907. The journal will be published semi-monthly.

The corps of those in charge of the various divisions of the journal is already well organized and work upon the abstracts has been commenced. It is intended to include in the journal abstracts of all new work in chemistry published in the world after October 1, 1906. Chemical patents issued in the United States, Germany, France and England after July 1, 1906, will be included. The abstracts will be classified under the following divisions, the selection of abstractors and the oversight of each division being placed in the hands of the persons named:

Apparatus: W. H. Walker.
General and Physical Chemistry: G. N. Lewis.
Photography: L. H. Friedburg.
Electrochemistry: W. R. Whitney.
Radioactivity: H. N. McCoy.
Inorganic Chemistry: Alexander Smith.
Analytical Chemistry: L. M. Dennis.
Mineralogical and Geological Chemistry: W. F. Hillebrand.
Metallurgy: J. W. Richards, Henry Fay.
Acids, Alkalies and Salts: T. L. Briggs.
Glass and Pottery: G. E. Barton, Albert V. Bleininger.
Cements and Mortars: Harry Drew.
Fuel, Gas, Coke: J. D. Pennock.
Organic Chemistry: M. T. Bogert.
Petroleum, Asphalt, Turpentine, Wood Products: S. S. Sadtler.
Cellulose, Paper: A. D. Little.
Explosives: C. E. Munroe.
Dyes, Textile Fabrics, Bleaching, Inks: L. A. Olney.
Pigments, Resins, Varnishes, India Rubber: A. H. Sabin.
Fats, Fatty Oils and Soap: W. D. Richardson.
Sugar, Starch and Gum: C. A. Browne, Jr.
Leather, Glue: J. H. Yocum.
Biological Chemistry: L. B. Mendel.
Foods: W. D. Bigelow.
Nutrition: C. F. Langworthy.
Water, Sewage, Disinfectants, Insecticides: L. P. Kinnicutt.
Fermented and Distilled Liquors: Robert Wahl.
Pharmaceutical Chemistry: A. B. Stevens.
Soils and Fertilizers: F. P. Veitch, J. H. Pettit.
Patents: W. H. Seaman.

In order to cover the expense of the new publication the dues of the society will be increased from five to eight dollars per year. It is expected for the first year or two at least the cost of the abstract journal will be considerably greater than the increased receipts from dues, but the vote of the society upon the matter has given evidence of such a strong desire for the establishment of the journal that it is hoped that the increase in membership will be sufficient to support the enterprise financially within a very few years.

The *Journal of the American Chemical Society* will be continued and will contain original articles, book reviews and reviews of recent progress in the various fields of chemistry.

SCIENTIFIC NOTES AND NEWS.

DR. CH. WARDELL STILES, of the Public Health and Marine Hospital Service, has been named one of the experts to be sent to Germany to investigate customs tariff complaints.

THE sum of about $5,000 has been subscribed for the foundation for the advancement of geographical study in honor of Dr. von Neumayer.

DR. OTTO BÜTCHLI, professor of zoology at Heidelberg, has been elected an associate of the Royal Academy of Belgium.

DR. HEINRICH BRUNS has celebrated the twenty-fifth anniversary of his directorship of the Leipzig Astronomical Observatory.

DR. WILHELM WALDEYER, professor of anatomy at Berlin, and secretary of the Berlin Academy of Sciences, has celebrated his seventieth birthday.

DR. L. A. BAUER, assisted by Messrs. P. H. Dike and E. H. Bowen, of the Department of Terrestrial Magnetism of the Carnegie

Institution, of Washington, during September and October determined the three magnetic elements (declination, dip and intensity) at 70 stations in the portion of Canada bounded by the parallels of latitude 42° and 49° and the meridians of longitude 65° and 105° west. In this region very few observations had previously been made. With the completion of this work it is now possible to extend the magnetic maps for the United States up to the forty-ninth parallel across the entire continent. The standard magnetic instruments of the Toronto Magnetic Observatory were likewise compared with those at the Cheltenham Magnetic Observatory, making it possible thereby to reduce all the magnetic work in the United States and Canada to the same standard. Through the courtesy of Professor Stupart, director of the Canadian Meteorological Service, the Toronto Magnetic Observatory, situated at Agincourt, was made available as the base station for the work undertaken by the Carnegie Institution.

Professor Savas, of the University of Athens, has recently visited the Liverpool School of Tropical Medicine with view to obtaining information in regard to the extermination of mosquitoes. It is said that in a Greek population of 2,500,000 there were, last year, 960,000 cases of malaria.

Four members of the faculty of Wells College have been given leave of absence for the year 1906–7: Professor J. W. Frelev (physics), Professor Dolson (philosophy), Professor Van Benschoten (mathematics) and Professor Vernette L. Gibbons (chemistry).

Dr. A. Backhaus, professor of agriculture at Königsberg, has been given leave to absence for four years, to become director of the agricultural school in Montevideo, Uruguay.

Dr. Cooper Curtice has resigned from the Rhode Island College to take up work in the Bureau of Animal Industry in connection with the eradication of the Texas fever tick.

Dr. T. J. Headlee has been appointed entomologist at the New Hampshire College.

F. A. Potts, B.A., of Trinity Hall, has been appointed assistant to the superintendent of the Museum of Zoology, Cambridge

Dr. A. Wassermann has been made director of one of the departments of the Institute for Infectious Diseases at Berlin.

Dr. B. Hagen, of Frankfort, has received 1,700 Marks from the Bavarian Academy of Sciences towards his publication of an atlas illustrating the types of heads and faces of East Asiatic and Malaysian races.

The annual dinner of the New York Association of Biology Teachers will be held at the Tuxedo, Madison Avenue and 59th Street, on Friday evening, November 9. Professor E. G. Conklin, head of the department of zoology, of the University of Pennsylvania, will be the guest of the association and will make an address on 'Biology and Life.'

Professor Walther Nernst, professor of physical chemistry in the University of Berlin, delivered a lecture at the Johns Hopkins University, on October 19, before the graduate students in physics and chemistry. He gave an account of his work on the dissociation of water-vapor at high temperatures.

Professor Henry Fairfield Osborn gave a public lecture under the auspices of the New York Academy of Sciences at the American Museum of Natural History, on October 29, his subject being 'The Collection of Extinct Elephants in the American Museum.'

Dr. D. Randall MacIver, of Oxford, gave a lecture under the auspices of the American Ethnological Society at the American Museum of Natural History, on October 29, on 'The Ethnology and Archeology of North and South Africa.'

The Swiney lectures on geology in connection with the British Museum of Natural History will be given this year by Dr. R. F. Scharff. The course of twelve lectures, which begins on November 5, has as its subject 'The Geological History of the European Fauna.'

The graduates of the classes of '04, '05, '06 and '07 of Sibley College, Cornell University, will erect a memorial to Robert H. Thurston, late director of the college.

Dr. Josef Weinlechner, formerly professor of surgery at Vienna, has died at the age of seventy-six years.

THERE has been added to the Agassiz Museum, Harvard University, a valuable collection of Hawaiian fishes, representing 140 species, presented by Sherman F. Denton, of the Bureau of Fisheries.

MR. J. OGDEN ARMOUR has offered to give $5,000 annually, through the International Live-Stock Exposition, for scholarships to be competed for by the state agricultural colleges at the live stock exhibitions.

THE Middlemore prize of the British Medical Association will be awarded in 1907 for an essay on *Ophthalmia Neonatorum*.

THE twenty-fourth annual congress of the American Ornithologists' Union will convene in Washington, D. C., on Monday, November 12, at 8 P.M. The evening session will be devoted to the election of officers and the transaction of other routine business. The meetings open to the public and devoted to the reading and discussion of scientific papers will be held in the lecture hall of the United States National Museum, beginning on Tuesday, November 13, at 11 A.M., and continuing for three days.

AT the recent Stuttgart meeting of German Men of Science and Physicians a Society of German Neurologists was organized.

THE German Astronomical Society met this year at Jena, on September 11 and the following days, with an attendance of more than sixty members. The meeting next year will be in Vienna.

The Experiment Station Record states that the eighth International Congress of Agriculture will be held at Vienna, Austria, May 21–25, 1907. The previous congresses were held at Paris, 1889; The Hague, 1891; Brussels, 1895; Budapest, 1896; Lausanne, 1898; Paris, 1900 and Rome, 1903. A pamphlet has been issued giving the organization, regulations and program of the forthcoming congress. This contains the subjects for discussion of each of the eleven sections in which the congress is to be divided. All reports intended for the congress should be sent to the executive committee before December 1, 1906. Persons desirous of becoming members should notify the executive committee and pay the membership fee of 20 kronen ($4) before March 31, 1907. The secretary of the executive committee is Professor Josef Häusler, Vienna, Austria, I. Schauflergasse 6.

THE French Geographical Society has organized a mission to West Africa to study the sleeping sickness in the French Congo. A central laboratory will be established in Brazzeville. The sum of $40,000 has been collected for this work.

THE magnetic survey yacht *Galilee* of the Carnegie Institution of Washington returned to San Diego, California, on October 20, having successfully concluded under the command of Mr. W. J. Peters since March 2 a cruise of 20,000 miles, embracing San Diego, Fanning Island, Samoan Islands, Fiji Islands, Marshall Islands, Guam, Yokohama and return to San Diego. The accident to the *Galilee* at Yokohama, already noted in this journal, proved not to be as serious as at first appeared, so that the vessel was able to leave Yokohama on September 6, the trip to San Diego having been made in forty-four days, or at an average rate of about 115 miles a day. Mr. Peters' assistants were Messrs. J. P. Ault and J. C. Pearson, magnetic observers, and Dr. H. E. Martyn, surgeon and recorder. The sailing master as in the cruise of 1905 was Captain J. T. Hayes. The two cruises of 1905 and 1906 of this vessel have already furnished sufficient data for the revision of the present magnetic charts of the North Pacific Ocean. In order to obtain some results as soon as possible in the other oceans, it is now proposed to send the vessel shortly on the following cruise: San Diego, Valparaiso, Rio Janeiro, Washington, D. C., and from thence return to the Pacific Ocean by way of Cape of Good Hope and the Philippines.

THE University of Colorado had two parties in the field during the past summer, engaged in the study of the geology and natural history of parts of the state. One, in charge of Mr. Junius Henderson, the director of the museum, traveled northeastward from Boulder by wagon, covering a distance of about 400 miles. The country visited is the dry plain region of northeastern Colorado. Valuable

collections were obtained, some of the material being new to science. Visits were made to a number of the type localities of fossils. A good series of photographs was made to illustrate the topography and vegetation of the region. Professor T. D. A. Cockerell conducted an expedition to Florissant, Colo., where he obtained a valuable series of fossil insects and plants from the Tertiary lake-beds of that vicinity. A beginning of such a collection for the University of Colorado was made the year before, but at that time comparatively few specimens were obtained. The revival of interest in the fossils of Florissant is auspicious. Some of the known species have never been described, others have been improperly referred to European species from which they are distinct. The university has issued a pamphlet containing brief articles in popular language describing the geology, botany and paleontology of the Florissant region.

The Bulletin of the American Geographical Society states that the Service Géographique de l'Armée, to which is entrusted the topographic survey work of the country, is making excellent progress with the new map of France in eight or nine colors, which is being published on the scale of 1:50,000. The surveys are being conducted in the field on a scale of 1:10,000 in regions of moderate relief and of 1:20,000 in mountainous regions. Surveys on these scales are to form the basis of the new cartography of France. It is probable that the next publications will be maps of the environs of the other large cities of the country. It is estimated that the cost of producing the entire map will be $6,000,000; and as the appropriations thus far voted are small, it is likely that the progress of the map will be slow.

UNIVERSITY AND EDUCATIONAL NEWS.

The Georgia legislature has appropriated $100,000 to erect and equip a building for the Agricultural College.

The New York State College of Agriculture at Cornell University has received a gift of $30,000 for the foundation of six agricultural scholarships. Tuition in the college is free to students from New York State, and the scholarships will be a substantial help toward living expenses.

The University of Florida, in accordance with plans determined upon a year ago and mentioned in Science, October 13, 1905, has been removed during the summer from its former location at Lake City to new grounds and new buildings at Gainsville, Fla. The school year opened at the new location on September 26. The new grounds comprise a tract of five hundred acres just outside the city limits of Gainsville. Two three-story brick buildings have been completed, one 300 feet long by 30 feet wide, the other 240 feet long by 30 wide; a one-story brick building has been put up also to serve as shop; experiment station, barns and greenhouse are in process of construction.

The senate of Oxford University on October 25 adopted, by 206 to 169 votes, the recommendations of the special board for mathematics, involving the abolition of the publication of the names of students in the mathematical tripos in the order of merit. There will consequently hereafter be no senior wrangler.

Professor L. B. Judson, professor of horticulture in the University of Idaho, has been appointed assistant professor of horticulture in Cornell University, to take charge of subtropical pomology with some related courses. He has spent the past six weeks in traveling on the Pacific coast and the gulf states, and will assume his duties in Cornell on November 1.

The following instructors have been appointed in the Michigan Agricultural College: William E. Lawrence, botany; J. R. Kelton, zoology; E. N. Bates and W. L. Lodge, physics; F. J. Kayfmann, Arthur J. Clark and Herbert S. Bailey, chemistry; Jos. H. Taylor and W. B. Wendt, civil engineering; H. F. Schmidt and J. A. Palson, mechanical engineering.

Dr. Heinrich Rubens, professor of physics in the Berlin Technical Institute, will for the present assume the direction of the physical laboratory in succession to the late Professor Paul Drude.

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THE DEDICATION OF THE ENGINEERING BUILDING OF THE UNIVERSITY OF PENNSYLVANIA.

A COMPARISON OF UNIVERSITY AND INDUSTRIAL DISCIPLINE AND METHODS.

THE point from which I view college education is that of the employer, not that of the educator. I have had no experience with the difficult and complicated problem that faces the professors and the governing boards of our colleges. On the other hand, I have been engaged for years in organizing the shop, office and commercial management of quite a wide range of engineering and manufacturing establishments. This has brought me into intimate personal contact with a large number of college graduates, and I have become well acquainted with their strong points, which are many, and at the same time with a few of those points in which it would seem that as a class they might be improved. And in what I shall say I have principally in mind the preparation of young men for success in commercial engineering and industrial enterprises; in other words, enterprises outside of the four learned professions.

I despise the pessimist who sees nothing but the defects and blunders of mankind, and the scold, whose pleasure it is to complain of all things as they are.

Let me say at the start, that without question our college graduates as a class represent the finest body of men in the community. And as to the value of an engineering course for men in our profession, our fellow-townsman, Mr. Jas. M.

Dodge, in his admirable paper on 'The Commercial Value of an Education,' has shown through carefully gathered statistics, that within a few years after graduation the college educated engineer far outstrips in position and salary his average competitor who comes up from the ranks.

It would be a much more congenial task to dwell upon this view of the profession, but something may possibly be gained by considering what has seemed to many of the friends of our young graduates to be the one defect which they practically all have in common.

For a period of from six months to two years after graduating they are, generally speaking, discontented and unhappy. They are apt to look upon their employers as unappreciative, unjust and tyrannical, and it is frequently only after changing employers once or twice and finding the same lack of appreciation in all of them that they finally start upon their real careers of usefulness.

On the other hand, the attitude of employers towards young graduates is fairly expressed by the following written instructions given for the selection of quite a large number of young men to fill positions which presented opportunities for rapid development and advancement. These instructions were to give the preference—first, to graduates of technical schools; second, to the graduates of the academic departments; but to employ no college boy who had not been out for more than two years.

Why is it, then, that these young men are discontented and of practically little use during the first year or two after graduating?

To a certain extent this is unquestionably due to the sudden and radical change from years spent as boys almost solely in absorbing and assimilating knowledge for their own benefit to their new occupation of giving out and using what they have for the benefit of others. To a degree it is the sponge objecting to the pressure of the hand which uses it. To a greater degree, however, I believe this trouble to be due to the lack of discipline and to the lack of direct, earnest and logical purpose which accompanies, to a large extent, modern university life.

During the four years that these young men are at college they are under less discipline, and are given a greater liberty than they have ever had before or will ever have again.

As to college discipline, it can not be a good training for after life for a young man deliberately to be told by the university authorities that he can flagrantly neglect his duties sixty times in one term before any attention will be paid to it; while, if in business, the same young man would be discharged for being absent two or three times without permission.

And, as to the freedom offered by the modern university system, it is not true that boys from eighteen to twenty years old have the knowledge and experience necessary to select a logical and well-rounded course of studies, and even if they had this wisdom, the temptation to choose those studies which come easiest is so strong that it would be unwise to throw upon them so great a responsibility. Nor does it appear wise to leave each student free to study as little or as much as may suit him, at times doing practically no work for days, and at others greatly overworking, with no restraint or direction except the round-up which comes twice a year with examinations. At the least, it must be said that in commercial or industrial life this undirected liberty will never again be allowed them.

During the past thirty years two radical changes have occurred in educational meth-

ods. The kindergarten and its accompanying ideas have come for the children, and for the young men has come the change from the college, with its one or two courses carefully selected and rigidly prescribed by the faculty, to the university with as many different courses as there are young men, and in which, under the elective system, each student is given the choice of all of his studies.

The fundamental idea back of the change from college to university is excellent; namely, that of providing a far greater variety in the courses to suit the different tastes and abilities of the students, and to especially prepare them for their future occupations. Accompanying, however, this great step in advance, and yet, so far as I can see, in no way logically connected with it, has come the false step of giving our young men in many ways a greater liberty than is allowed, on the whole, to any other class of active workers; and of handing over to them the final decision in a subject most needing a master mind.

Commercial, manufacturing and other enterprises in which many men cooperate, are managed more and more by delegating all important decisions to a few men whose judgment has been trained through long experience, study and observation in those matters which they are called upon to decide. Yet many of our universities are managed by giving over to the young man, under the elective system, the final decision as to what studies will best fit him for his life's work, although he has, of necessity, but the vaguest idea of the nature of the subjects which lie before him. It is almost like asking him to lift himself up by his boot straps.

I can not but think that in changing country we have modeled largely after the English and German universities, which, as we know, are influenced in their management by traditions handed down through several hundred years; and that in adopting the great university idea of a variety of courses, we have at the same time blindly accepted the foreign idea of the elective system accompanied by a lax discipline, both of which are better suited to medieval times when each man worked for himself than to the present day when the road to success lies through true cooperation.

In this change, also, too great stress has been laid upon those elements leading to knowledge or book learning on the part of the student and too little upon the development of his character.

The kindergarten also, which has proved so great a help in training the younger children, making them observant and giving them a certain control over themselves, has brought with it one idea which has wrought great harm, and yet this bad idea is in no way properly or logically connected with the underlying principles of the kindergarten.

Somehow the average kindergarten child gets a firm conviction that it is the duty of the teacher to make things interesting and amusing, and from this follows soon the notion that if he does not like his studies and fails to learn much, it is largely the teacher's fault. Now, whatever views the parents or the teachers themselves should hold upon the duties of teachers, there is no doubt that the boys should have firmly in their heads the good old-fashioned idea that it is their duty to learn, and not that it is the duty of the teacher to teach them.

Along with the kindergarten plan of interesting and amusing children, the idea has taken firm hold in a large portion of the educational world that the child and young man should be free to develop naturally, like a beautiful plant or flower. This may again be an excellent view for the older person to hold, but it is a distinctly bad one for the young man to act

upon. He promptly translates the idea of developing naturally into wishing to do only, or mainly, those things which he likes or which come easy to him.

Of all the habits and principles which make for success in a young man, the most useful is the *determination to do and to do right all of those things which come his way each day, whether they are agreeable or disagreeable;* and the ability to do this is best acquired through long practise in doggedly doing along with that which is agreeable a lot of things which are tiresome and monotonous, and which one does not like.

Now neither the kindergarten idea, the university elective system, nor the lax college discipline tend to develop this all important habit in young men.

True cooperation, cooperation upon the broadest scale, is that feature which distinguishes our present commercial and industrial development from that of one hundred years ago. Not the cooperation taught by too many among those of our trades unions which are misguided, and which resembles the cooperation of a train of freight cars; but rather that of a well-organized manufacturing establishment, which is typified by the cooperation of the various parts of a watch, each member of which performs and is supreme in its own function, and yet is controlled by and must work harmoniously with many other members.

It is a mistaken notion that character of this kind needed for successful cooperation is developed by the elective idea of allowing each boy to choose for himself those things which he will do. It requires far more character to do successfully those things which are laid out for one by a wiser man than to do only what one likes, and in modern cooperation, while the work of each man is modified and more or less controlled by that of others, there is ample scope left for originality and individuality. We must remember that of all classes in the community, college boys are being trained to fill some day the position of leaders in the cooperative field. And there is no fact better established than that the man who has not learned promptly and fully to obey an order is not fit to give one.

An examination of the studies chosen by boys in the university academic departments will show that the logic and motive back of about one half of the students is that of obtaining an easy course, and even the better students show generally a lack of clear-cut logical purpose in their selection. In their case, the studies are chosen because the young man likes or is interested in the subjects, or because they come easy to him, rather than because they give a well-rounded and balanced course with a distinct logical purpose. The loose, flabby, purposeless courses chosen by fully one half of the students under the present system furnish but poor mental diet.

Why can not all of the good features of the elective system be better attained by permitting each young man to choose in general the object or purpose for which he wishes to educate himself, and then leaving the entire course of studies to the one or more professors in the faculty who are especially fitted to plan a complete and logical course in the chosen field? Let the young man say where he wishes to go, and let the faculty tell him the road he is to travel to get there.

As to the object of college life, some boys are sent to the university to learn how to mingle with men, and to form friendships which shall prove useful and agreeable in after life. Some go there to amuse themselves, and some to get the standing given by a college degree.

Something can be said for each of these objects. Is not the true object of all education, however, that of training boys to be

successful men? I mean men successful in the broadest sense, not merely successful money getters. Successful, first in developing their own characters, and second, in doing their full share of the world's work.

Young men should not come to college mainly to get book learning or a wide knowledge of facts. The successful men of our acquaintance are, generally speaking, neither learned nor men of great intellect. They are men, first of all possessed with an earnest purpose. They have a certain all-round poise or balance called common sense. They have acquired through long training those habits, both mental and physical, which make them masters over themselves; and at all times they have the firm determination to pay the price for success in hard work and self-denial.

It is singleness and earnestness of purpose that constitutes the great motive power back of most successful men, and it is a notable fact that the moment a young man becomes animated with such a purpose, that moment he ceases to believe in the elective system, and in the loose college discipline.

In all earnest enterprises which the students themselves manage, they throw the elective system to the winds and adopt methods and a discipline quite as rigid as those prevailing in the commercial and industrial world.

The boy who joins the foot-ball squad is given no sixty cuts a season, nor is he allowed to choose what he will do. He does just what some one else tells him to do, and does it at the time and in the manner he is told, and one or two lapses from training rules are sufficient cause for expulsion from the team or the crew.

I say in all seriousness that were it not for a certain trickiness and a low professional spirit which has come to be a part of the game, I should look upon foot-ball and the training received in athletics as one of the most useful elements in a college course, for two reasons: First, because in it they are actuated by a truly serious purpose; and second, because they are there given, not the elective idea of doing what they want to, but cooperation, and cooperation of the same general character which they will be called upon to practise in after life.

Is not the greatest problem in university life, then, how to animate the students with an earnest, logical purpose?

In facing this question I would call attention to one class of young men who are almost universally imbued with such a purpose; namely, those who, through necessity or otherwise, have come into close contact and direct competition with men working for a living. These young men acquire a truly earnest purpose. They see the reality of life, they have a strong foretaste of the struggle ahead of them, and they come to the university with a determination to get something practical from the college training which they can use later in their competition with men.

They are in great demand after graduating, and as a class make themselves useful almost from the day that they start in to work.

Neither their earnestness of purpose, however, nor their immediate usefulness, comes from any technical knowledge which they have acquired while working outside of the university, but rather from having early brought home to them the nature of the great problem they must face after graduating. Nothing but contact with work and actual competition with men struggling for a living will teach them this. It can not be theorized over or lectured upon, or taught in the school-workshop or laboratory.

I look upon this actual work and competition with men working for a living as of such great value in developing earnest-

ness of purpose that it would seem to me time well spent for each student, say, at the end of the freshman year, to be handed over by the university for a period of six months to some commercial, engineering or manufacturing establishment; there to work as an employee at whatever job is given him, either manual or other work. He should have the same hours and be under the same discipline as all other employees, and should receive no favors. Moreover, he should be obliged to stay even a longer time than six months unless he has in the meantime given satisfaction to his employers.

I believe that there would be but little difficulty in obtaining the cooperation of our business and manufacturing establishments in carrying out this plan, and the University of Pennsylvania, situated as it is in the foremost manufacturing city in this country, would have an especially good opportunity to inaugurate it.

My belief in the benefits to be derived from doing practical every-day work early in the college course is not the result of a theory. It is founded upon close observation and study of young men who have had this experience, and also upon a vivid remembrance of breakfasting each morning at five-thirty, and starting to sweep the floor of a pattern shop as an apprentice some thirty-two years ago, after having spent several years in preparing for Harvard College. The contrast between the two occupations was great, but I look back upon the first six months of my apprenticeship as a patternmaker as, on the whole, the most valuable part of my education. Not that I gained much knowledge during that time, nor did I ever become a very good patternmaker; but the awakening as to the reality and seriousness of life was complete, and, I believe, of great value.

Unfortunately, laboratory or even shop work in the university, useful as they are, do not serve at all the same purpose, since the young man is surrounded there by other students and professors, and lacks the actual competition of men working for a living. He does not learn at college that, on the whole, the ordinary mechanics, and even poorly educated workmen, are naturally about as smart as he is, and that his best way to rise above them lies in getting his mind more thoroughly trained than theirs, and in learning things they do not know. All of this should be taught him through six months' contact with workingmen.

Let me repeat in conclusion that our college graduates are the best picked body of men in the community. Yet I believe that it is possible to so train young men that they will be useful to their employers almost from the day that they leave college; so that they will be reasonably satisfied with their new work instead of discontented; and to place them upon graduating one or two years nearer success than they now are; and that this can best be accomplished by giving them an earnest purpose through six months' contact early in their college life with men working for a living; by rigidly prescribing a course of studies carefully and logically selected, and with some definite object in view, and by subjecting them to a discipline comparable with that adopted by the rest of the world.

Philadelphia possesses and is proud of the most notable group of medical schools in this country, and among these that of the University of Pennsylvania unquestionably stands first.

The Philadelphia lawyer has been proverbial for his knowledge and shrewdness for more than a century, and this reputation can be traced largely to the fundamental training given in the law school of the University of Pennsylvania.

Philadelphia is the center of the largest and most diversified group of engineering

and manufacturing enterprises in this country. The Engineering Schools of the University of Pennsylvania already stand high; but it seems to me that the opportunity lies open to them even more than to their famous medical and law schools to stand at the very top. This magnificent building, equipped as it is with the latest and best of everything, is the first and a great step towards this end. But, after all, your largest possibility and one which does not exist for, and can not be created by, any other American university, lies in the opportunity for bringing your students into close touch and personal contact with the men who are working in and managing the great industrial establishments of Philadelphia.

FREDERICK W. TAYLOR.

THE ENGINEER AS A CITIZEN.

I CONSIDER it no small honor to be included as one of the participants in to-day's program. But though I come on the invitation of those in authority, I hesitate to appear before this audience, gathered in sympathy with so notable a step in the development of one of the greatest of America's universities, a university presided over by a man eminent as an educator, an administrator, and a man of affairs, to express my opinions on questions of engineering education and citizenship and their correlation.

In spite of apprehensions as to my insufficiency for the duty I have accepted, I shall make no apology, but fall back upon the fact that, having been called to serve the university to which as an adopted son I proudly owe allegiance, it remained for me but to obey. I can only promise you that I shall not vaguely theorize, but I shall speak from my personal experiences in the fields of business, engineering and education.

In coming before you as the president of Stevens Institute of Technology, I come as the successor of your own Henry Morton, a graduate of, and later a professor in, your university, secretary of the Franklin Institute, professor in the Philadelphia Dental College, brilliant lecturer, profound scientist, man of affairs, but above all a simple-minded seeker after the truth, too modest to recognize his own great qualities of mind, qualities combining the grasp of genius with the sanity of common sense.

It is peculiarly appropriate that the University of Pennsylvania should develop a thoroughly efficient department of engineering education in view of the important scientific work done by the many-sided Franklin, upon whose suggestion the original Philadelphia Academy was organized.

In view of what I have in mind to say to-day, I am particularly struck by the following words which appear in the original charter granted to the academy in 1753 by Thomas and Richard Penn:

> The well-being of a society depends on the education of their youth, as well as, in great measure, the eternal welfare of every individual, by impressing on their tender minds principles of morality and religion, instructing them in the several duties they owe to the society in which they live, and one towards another, giving them the knowledge of languages, and other parts of useful learning necessary thereto, *in order to render them serviceable in the several public stations to which they may be called.*

It is interesting to note that the charter of 1755, creating the college, enlarged the scope of work to include 'Not only the learned languages, but the liberal arts and sciences.'

Since Franklin's day, tremendous strides have been made in the sciences and especially of late years in that branch in which he did pioneer work—electricity.

It is to the credit of this university that it has recognized its responsibility in connection with this advance, and has quietly progressed in the line of engineering edu-

cation until to-day we are assembled to recognize formally the addition to its educational plant of a complete engineering building, probably second to none of its kind and equipped to give adequate instruction in several branches of engineering.

Should not this magnificent growth from so small a beginning strengthen our faith and be an encouragement to all of us who are struggling to meet our responsibilities along similar lines?

There is passing over the United States to-day a wave of reform—some of it real and honest—much of it not so. To-day reform is popular and to a certain point I am willing, yes anxious, to go with the popular party.

Reform is needed, much needed, in the United States and in many directions. And reform always has been needed and always will be needed in this world of ours. Here is where the first mistake is made by the reformers. Their proposition seems to be that the conditions now attracting their attention are singular.

The people at large have been deceived as to our condition in connection with the need of reform as compared with times past. Many men of standing hold the opinion and are willing to act on the belief that the present condition as to the wrongful use of the money power is such that relief can be found only through a revolutionary upheaval. If the case is so desperate that a surgical operation is required, let us hope that our republic will not be in the position of the unfortunate patient who dies under the knife, although the surgeon declares the operation to have been successful.

And what has been the chief agency in this deception? Unquestionably, yellow journalism.

Yellow journalism of the ordinary sensational type is an old story in America. Dickens shows us—perhaps the picture, caricature-like, is an exaggeration, but, caricature-like, it contains the elements of truth—that yellow journalism had a footing with us in the days of Martin Chuzzlewit and Mark Tapley. Comparatively, this type is harmless. But the extreme yellow journalism of to-day is something very different. We now have to face a systematic effort to deceive the people by a partial telling of the truth and an extended telling of untruth, with the deliberate intention of stirring up discontent and antagonism between classes.

Public opinion in connection with our form of government is a necessary safeguard of liberty. But to be a safeguard, it must be sane public opinion, and not public clamor instigated by a section of the press which is influential in spite of being conscienceless.

There are too many to-day who are willing to push aside their individual responsibility in this connection by relying, or pretending to rely, upon the good sense of the so-called plain people. But these yellow journals are sedulously and constantly engaged in the effort to corrupt this good sense.

Others tell us that our republic is safe in the hands of our young men. These are urged to take part in political movements and especially in movements looking to the betterment of civic conditions. Undoubtedly, if rightly employed, here is a powerful agency for good. But these young men must not be encouraged to believe that they are capable of helping the cause of good government simply because of their youth. As a rule inexperience and immaturity go with youth. If in our public affairs we need the fire and enthusiasm of youth, as we do, we also need thorough knowledge of facts, followed by their judicial application. Real reform must be based upon a careful, competent, honest

consideration of all obtainable evidence and data.

To-day, all over the land, we find indiscriminate abuse of corporations. What is fair and honest is condemned along with that which is unfair and dangerous to our national life. If we condemn indiscriminately and thus unjustly, so surely will there be a reaction, and public opinion, seeing that injustice has been done, will be carried to the other extreme and again become indifferent to real evils. And the last condition shall be worse than the first.

If wrong has been done under the mantle of trusts and corporations—and unquestionably such is the case—that is no reason that we should believe that corporations as such are necessarily evil in their work and influence. It is a commentary on the sincerity of some of the most blatant of yellow journalists that, while condemning corporations as a whole, they avail themselves of the protection to be found in corporate organization to secure immunity from personal responsibility.

And are we not forced to acknowledge, much as we may regret the necessity, that the yellow journals have been given their opportunity all too often through the hasty, intemperate, non-judicial utterances of those occupying the highest positions within the gift of the people? Are these men, occupying their high positions through the votes of the people who have trusted them, to be absolved from responsibility because they plead, or the plea is entered for them, that they are sincere in their beliefs, are personally honest in their acts and have effected reforms in spite of their indiscretions? They can not so escape their final responsibility.

It used to be thought that responsibility thrust upon an office-holder would steady him and make him a safer guide than his public utterances before election had seemed to warrant.

The effect of the present tendency to destructive criticism is to kill or at least discourage individual enterprise. National enterprise can result only from individual enterprise; and the latter necessarily is held in check and finally killed if the individuals come to believe that the government will not permit them to reap fairly where they have sown.

Much, perhaps nearly all, of the present unrest comes from lack of information and from misinformation as to the conduct of certain of our industries. The evils which flow from general lack of information are systematically cultivated by misinformation supplied by the worst of the yellow journals.

Then to-day the problem is—how shall we correct the false impressions created by those who systematically aim to deceive and by those who, while honest in intention, are not deterred from rash statements by their ignorance and inexperience?

First, we should be firm not to believe evil of any one or anything on the unsupported statements of the yellow press. Beyond that the remedy must come from the dissemination of the truth. The nation as a whole needs the honest services of those who know.

But it may be asked, why this discussion in connection with the dedication of a building to be devoted to engineering education? I will try to show in a few words that this discussion is appropriate to the occasion.

In this country the varied and bountiful gifts of nature have, in no small degree, been utilized for the common good through the efforts of the workers in pure and applied science. This country's present commanding position in the industrial field is, in considerable measure, due to the efficient preparatory work done by our engineering schools. And incidentally let me say, while all classes have, directly or indirectly, prof-

ited by the industrial prosperity of the nation, it is to be deplored that those who have acquired great wealth from industrial undertakings have *as a class* failed to show in a practical way their appreciation of their obligations to these institutions.

To whom should the public look for the facts concerning industrial undertakings? Certainly to those who are engaged in the work, who understand the underlying principles involved; who, knowing all the details and appreciating that part truth often serves to deceive, are honest enough to tell the truth, the whole truth and nothing but the truth.

During the last decade the management of our industries has been falling more and more into the hands of the men who have received a preliminary training in our engineering colleges. If this is to continue, it must be the graduates of our technical colleges to whom we must look more and more for protection from the evils to which I have referred. Questions are continually arising which can be settled only through expert advice. The people must come to have confidence in those who give these expert opinions. Unfortunately, the title 'expert' has been too often degraded by those who have assumed to speak as such. Too often our experts accept retainers to tell part only of the truth and possibly to cloud over, distort or deliberately hide other parts of the truth. Such expert advice brings discredit upon our profession and affords an opportunity which the enemy is not slow to seize.

Again, the so-called expert often errs through ignorance. It must come to be recognized within our own ranks that the fields of science and practise have so widened of late years that no man can honestly claim to be able to cover authoritatively more than a limited area of either of these fields.

There are a number of fairly well defined branches of engineering, such as civil, mechanical, mining, naval, electrical and chemical. But no one man can hope even to cover authoritatively every portion of any one of these branches. To be thoroughly efficient, the engineer must closely specialize within his profession. And yet we find public opinion on intricate and complex industrial questions based upon the dictum of men who have at the best but a general knowledge of the matters involved. Especially it is to be regretted that graduates of engineering colleges, possibly competent in some one branch of the great field of engineering, presume to instruct in connection with some other branch on which their knowledge is only of a general character.

But the technical adviser, be he scientist or engineer, to serve the state as I have indicated, must have more than a knowledge of material things, he must be honest to the core.

Education is a boon. It is well for a nation that its youth should be educated, as was argued by your Benjamin Franklin and his associates. But a little knowledge is a dangerous thing and much knowledge may be even more dangerous if not built on the foundation of character.

The engineer, to be an engineer in anything more than title, must be practical. His work must be based upon correct and complete theory, but it must be first and last practical. Can the engineer—that is, the civil engineer as distinguished from the military engineer—be practical, can he economically apply the truths of nature for the benefit and convenience of mankind; in other words, can he really be an engineer, unless he is competent to practise his profession within the necessary commercial limitations and in accordance with standard business methods? Can he disregard the question of return on investment? These questions, if fairly put,

answer themselves. But still there are engineers who seem to believe that engineering is something which can be practised without regard to money values and that others can be trusted to coordinate the engineering and commercial elements of the enterprises in which they are concerned. These men may be ingenious inventors or designers, they may be great mathematicians, they may even be eminent as scientists, but they are not engineers. The man who is willing to scientifically spend a dollar to save fifty cents can not be classed as an engineer nor can he be of much assistance in meeting the present yellow-journal danger. The man to so serve the cause of truth must be fully qualified to practise his profession in conformity with the limitations of commercial and industrial practise; to the knowledge and training gained in the school of engineering he must have added that knowledge and training which is to be gained only in the exacting school of experience.

Then the question is raised—what should the college education include that is not now generally covered in the regular four years' course? First it must be acknowledged that the courses in place of other material obsolete are crowded to the point where nothing more can safely be added unless there is a corresponding elimination. Through the steady and rapid advance in engineering science we are constantly having thrust upon our attention new matter for introduction into our courses. But where this new material can not advantageously be substituted as illustrations and applications of scientific truths in place of other material obsolete through displacement, the new must necessarily be refused admission. We must encourage ourselves in the reflection that our engineering courses are, after all, preliminary, and to a certain extent, elementary, and that it must in any case remain for each student after graduation to thoroughly learn all the details of some one—possibly narrow—branch of engineering or industrial operation. While every engineer-student should, after four years, have a good general knowledge of engineering science and practise and be thus prepared to acquire rapidly and surely a specific and certain control of some one branch of the profession, we must recognize that we can not graduate our men as fully equipped engineers, ready to assume positions of responsibility in any part of the engineering field. And are not the employers often at fault, even some of those who themselves are graduates in engineering, in expecting the young graduate to be able at once to do work which probably the employer himself was not qualified to do for years after his graduation? Is not too much expected of the modern education? There is no royal road to learning, there never will be, and no progress in educational methods will ever relieve the students from the hard work required for mental discipline and specific training. Should we not constantly bear in mind that the amount of work required in the four years should be limited to the capacity for thorough work by the eighty per cent. student?

How, then, with the four years already crowded, are we to find time to give our students some preparatory training in the branches required to enable them to take up their work in conformity with commercial requirements? First let us see if we can agree with Huxley that "The great end of life is not knowledge but action. What men need is as much knowledge as they can assimilate and organize into a basis for action; give them more and it may be injurious." Is it not probable that in certain directions we are giving our students more than they are yet prepared to assimilate and organize as a basis for action? Should they not be subjected to a

well-balanced course? Should they not then at least be taught the necessity for practising in conformity with commercial limitations and methods?

I contend that every engineer-student should have some instruction in the principles of accounting, in depreciation, business law, patent law, banking, specification, and even of sociology. And in connection with the business side of their training they should be made to see the importance of the correct use of language. They should be given opportunities to see how the work of the world is impeded and hindered through the ambiguous expression of thought. They should be taught that it is not enough to know, but that they must be able to give effect to their knowledge through the use of correct, clear, explicit and forcible language. More particularly in this business department they should be warned by those who can speak from experience of the pitfalls into which they are liable to fall and especially through the efforts that probably will be made to purchase their professional opinions if these opinions prove to be of value. Here, as in no other department, can the ethics of the profession be impressed upon the young engineer-student. As religious instruction is excluded from engineering courses, it is all the more incumbent upon us to show our students the lines along which they should practise if they wish to maintain their self-respect.

Some authorities oppose the broadening of our schemes of instruction on the score that necessarily the effect must be to make them less specific and more superficial. Others oppose making the courses more technically specific on the score that necessarily the effect must be to narrow them. I venture to maintain that the change I recommend would broaden the instruction and also make it more thorough and more specifically adapted to the needs of the engineer-student. To reach this result the selection of matter for elimination must be made with the utmost care, keeping constantly in view the work for which the engineer-student is being specifically trained and that we are not only giving him knowledge but we are training him to think straight and that it will remain for him to acquire in the school of experience that additional training in application which can not be obtained elsewhere.

In this university you are already equipped as few educational institutions are to supplement as I have suggested the studies more directly concerned in the technical side of engineering. I refer to the Wharton School of Finance and Commerce.

Even if only one hour a week during the junior and senior years could be devoted to these economic subjects, the students would be better prepared to go out into the industrial world to promptly equip themselves to take authoritative positions, positions from which they could do much to counteract the danger arising from the indiscriminate condemnation by yellow journals of the results obtained from the combination of capital and individual enterprise working under corporate organization. Even if, with the time saved by elimination of studies of less comparative value, we could only give our students before their graduation a keen appreciation of their need of the class of knowledge I have referred to, the time would be well spent.

This is an industrial nation and the people should therefore have the opportunities to learn the truth as to the fundamentals of industrial management, and the lawmakers should have the opportunities to learn the special conditions, local and otherwise, affecting each branch of industry. This information must come from those who, knowing the truth, are willing to place it before the public. The public must first

have confidence in the ability and integrity of their informants, and here it becomes the duty of our technical colleges to train their students to take the positions in the world of industry which will qualify them in their several stations to fully serve their country as fountains of truth.

In conclusion, let me quote a passage from an address by that ardent champion of truth, Thomas Huxley, delivered in 1880, upon a somewhat similar occasion to the present, namely, the opening of the Technical College in Leeds.

> * * * It is not beside the mark to remind you, that the prosperity of industry depends not merely upon the improvement of manufacturing processes, not merely upon the ennobling of the individual character, but upon the third condition, namely, a clear understanding of the conditions of social life on the part of both the capitalist and the operative, and their agreement upon common principles of social action. They must learn that social phenomena are as much the expression of natural laws as any others; that no social arrangements can be permanent unless they harmonize with the requirements of social statics and dynamics; and that, in the nature of things, there is an arbiter whose decisions execute themselves.
>
> But this knowledge is only to be obtained by the application of the methods of investigation adopted in physical researches to the investigation of the phenomena of society. Hence, I confess, I should like to see one addition made to the excellent scheme of education propounded for the college, in the shape of provision for teaching sociology. For though we are all agreed that party politics are to have no place in the instruction of the college; yet in this country, practically governed as it is now by universal suffrage, every man who does his duty must exercise political functions. And, if the evils which are inseparable from the good of political liberty are to be checked, if the perpetual oscillations of nations between anarchy and despotism is to be replaced by the steady march of self-restraining freedom, it will be because men will gradually bring themselves to deal with political, as they now deal with scientific, questions; to be as ashamed of undue haste and partisan prejudice in the one case as in the other; and to believe that the machinery of society is at least as delicate as that of the spinning-jenny, and as little likely to be improved by the meddling of those who have not taken the trouble to master the principles of its action.

ALEX. C. HUMPHREYS.

SCIENTIFIC BOOKS.

Entomology, with Special Reference to its Biological and Economic Aspects. By JUSTUS WATSON FOLSOM, Sc.D., Instructor in Entomology in the University of Illinois. Philadelphia, P. Blakiston's Son and Co. 1906. $3.00.

There is supposed to be a growing demand for a biological treatment of entomology, and two notable efforts have recently been made to meet it. Professor Kellogg met it in his 'American Insects' by adding to the systematic treatment of the older standard texts (which he incorporated *in toto*) a few chapters on color, insects and flowers, insects and disease, etc., making a very big book of the encyclopedic sort. Dr. Folsom has followed the plan of cutting down to an almost negligible quantity the systematic part, giving a condensed résumé of anatomy, physiology and embryology, and devoting the greater part of his book to the discussion of general biological phenomena, making it a reading book of comfortable size. Thirteen pages of systematic description of the orders serve to eliminate that part of the subject (which, according to the preface, is thus summarily dealt with because of its prominence in other available texts). The condensation is at its maximum in the description of the larvæ of the orders, for which purpose two words, *thysanuriform* and *eruciform*, suffice. The theoretical significance of these terms is explained in the chapter on development: but here in the descriptive part they are very much over-worked. To say merely that the larvæ of the Odonata are thysanuriform is certainly not very illuminating. Only with the mind's eye could one see, for instance, anything thysanuriform in the larva of *Hagenius*.

The chapters on morphology and development (158 pages) are concise, well digested and altogether excellent, and taken in connection with the well-selected bibliography at the

end of the book, furnish a good introduction to these subjects.

Then follow the chapters embodying the 'biological treatment' comprising the greater part of the text (183 pages). Their titles are the following: Adaptations of Aquatic Insects, Color and Coloration, Adaptive Coloring, Origin of Adaptations and of Species, Insects in Relation to Plants, Insects in Relation to Other Animals, Interrelations of Insects, and Insect Behavior. While these subjects are not new to entomological text-books, they are here given a new treatment and merited prominence, and entomologists will appreciate having them brought together for discussion in one place.

Then follow chapters on Distribution, and on Insects in Relation to Man, the latter being a discussion of the mission of the economic entomologist and a historical sketch of the evolution of that species in America. The economic entomology of the book is mostly in the title, where it, perhaps, serves the publisher's purpose. There is no mention of many of the most important economic species, nor of the most important methods of economic procedure. The book concludes with a good bibliography, of 57 pages.

The typography and press work are excellent. Mistakes are few; but in the short chapter on adaptations in aquatic insects the following are noted: The figure of the hind leg of the diving beetle *Cybister* on page 187 fails to show the inferior spur greatly widened—the character by which this genus is most readily recognized; the figure of *Simulium* larva on page 190 does not show the anal gill tuft, although illustrating a paragraph on gills; it is doubtless by oversight that the larvæ of Ephemeridæ are mentioned on the same page along with those of the Odonata as having a highly developed rectal respiration. The style is never prolix, and although verbal infelicities are rather too frequent, the meaning is rarely obscure. The illustrations are always appropriate, and generally of a high order. The book as a whole is excellent, and will be most useful to the general student.

J. G. N.

The Elements of Geology. By William Harmon Norton. Ginn and Co. 1905.

This volume has been written, the author tells us, to fill the need of a text-book that shall knit cause and consequence in geology together, 'to treat land forms and rock structures in connection with the geologic processes causing them,' abandoning the traditional division of the subject into departments, dynamical, structural, physiographical and historical. As a matter of fact, he preserves the last of these, so the new departure must be looked for in the rest of his book, 'External Geological Agencies and Internal Geological Agencies.' We readily obtain an idea of the treatment attempted by comparing Professor Norton's book with a well-known predecessor. For this I have put equivalent parts of LeConte's text-book and this on the same lines of parallel columns. It thus appears that our author has omitted the 'Structural Geology' and some of the 'Organic Agencies' and put the rest under slightly different heads:

Norton.	LeConte.
I. External Geological Agencies.	I. Dynamical Geology.
II. Internal Geological Agencies.	1. Atmospheric Agencies.
	2. Aqueous Agencies.
	3. Igneous Agencies.
(Touched in I.)	4. Organic Agencies.
(Touched in I. and II.)	II. Structural Geology.
III. Historical Geology.	III. Historical Geology.

Of LeConte's organic agencies, peat is described by Norton under river deposits, lime accumulations under offshore and deep sea deposits, and the bog ore, silicious and phosphatic deposits that get a brief mention in LeConte are not here referred to.

Of the structural geology, general form and structure of the earth are omitted as far as I have been able to learn, sedimentary rocks are treated in several places, one half page in the Introduction, five pages in the Work of the Weather, twenty pages in Offshore and Deep-sea Deposits, six pages in River Deposits and about three pages in the Work of the Wind. Igneous and metamorphic rocks are treated under internal agencies, joints under the work of the weather and movements of the earth's crust, faults under movements of the earth's crust, mineral veins under work of ground water and metamorphism and mineral veins,

while denudation comes under rivers and valleys. In general the chief novelty has been the omission of structures as a separate group. The result is separations as well as connections. We learn of river deposits in connection with the study of rivers as agents, but to learn about sandstones we must go to three or four separate parts of the book. If there are gains there are losses to set over against them.

From the reviewer's point of view this is a very beautifully illustrated volume in which physiography is unusually prominent. Omit the historical third part, the weakest part of the book, and add a little here and there about man, plants and animals and the book would fall perfectly into a class of recent text-books of physical geography, all with some general similarity to Davis's 'Physical Geography,' but lacking its classification and evolution of the forms of the earth's surface. The physiographic half-tones are mostly very beautiful both in appearance and in teaching value. 'A Lake well-nigh effaced, Montana' and 'A level Meadow, Scotland,' pages 71 and 72, seem to me unsurpassed as illustrations. All localities are rather vaguely referred to as here, though it is hard to see why. Professor Norton evidently knows where these places are and students would certainly find some interest in sharing his knowledge. There are practically no references to other books, either. The presswork is of course admirable, though a beginner will wonder at a 'parted laver' (p. 217). The diagrams are less satisfactory, some of them stiff and difficult to read. The map of Niagara gorge at page 60 has evidently been copied from Gilbert's paper in the National Geographic monographs though it is not so credited. Unfortunately, it has been redrawn and badly redrawn, so that it quite conceals the variations in width that are very marked in the original and afford even better evidence of varying erosion by the river than the depth of the gorge does, as Taylor has shown. A similar thing appears to have been done with the cut of the silurian scorpion at page 339. It strongly suggests the woodcut figured 347 in Geikie's manual, but redrawn with the omission of the artist's name, which in Geikie shows very plainly. There is no acknowledgment to any one, though about one third of the cuts are acknowledged borrowed, a dozen from the author! Most of the illustrations in the 'Historical Geology' have a familiar look. Dana and Geikie come quickly to mind at sight of figures 331, 338, 339 and 336. None of them, however, are credited.

The historical part does not seem to have received so much of the author's attention as the earlier portions of the book, nor even so much attention as its importance merits. This undertreatment disappears when we come to the Quaternary and the Ice Age. The physiographic is everywhere the part best developed. In matters of fact the work seems painstakingly accurate. That it is somewhat dogmatic is, perhaps, pardonable in an elementary text-book. Yet, if alternative views had been stated occasionally it would help the student avoid the 'common error' referred to by Professor Davis in his godfatherly note, of thinking 'authorities' have a private road to information. Thus 'lateral secretion' appears to be the only view of the origin of mineral veins that Professor Norton cares to entertain. For him Posepny does not exist, nor waters from the depths. Yet Professor Gregory has just been returning from Australia, stating that the so-called artesian waters of New South Wales are all deep waters soon to be exhausted. At page 331 Professor Norton calls the waters artesian that ascend in borings after gas has given out! There is no doubt that many teachers could find this volume helpful in giving students interest in earth science without necessarily appreciating at the author's estimate the particular need he has sought to fill.

MARK S. W. JEFFERSON.

YPSILANTI, MICH.,
October 17, 1906.

SCIENTIFIC JOURNALS AND ARTICLES.

The Botanical Gazette for October contains the following leading articles: George F. Atkinson gives a detailed account of the development of *Agaricus campestris*, illustrated by six photographic plates. William Crocker publishes the results of an investigation of

delayed germination of seeds, discovering that the cause generally lies in the seed coats, rather than in the embryos. In the case of the well-known 'upper seed' of the cocklebur, it is found that the delay is secured by the seed coat excluding oxygen; while in many seeds it is secured by the coats excluding water. John Donnell Smith publishes his twenty-eighth paper entitled 'Undescribed Plants from Guatemala and Other Central American Republics.' Clayton O. Smith describes with the aid of half-tone illustrations a bacterial disease of Oleander occurring on young Oleanders in California, which proves to be the same disease that causes knot-like growths on the olive.

The November *Journal of Nervous and Mental Disease* opens with a discussion of the cerebral element in the reflexes and its relation to the spinal element by Dr. G. L. Walton and Dr. W. E. Paul. Dr. Wharton Sinkler contributes the report of a case of Landry's paralysis with the unusual result of recovery, and Dr. Morton Prince gives an account of a case of brain tumor characterized by a circumscribed limited area of anesthesia, marked muscular atrophy appearing early, epileptiform attacks of hemialgesia of a peculiar nature; loss of the muscular sense, astereognosis, ataxis and paresis, increasing to ultimate paralysis. A study by Dr. Harvey Cushing of sexual infantilism with optic atrophy in cases of tumor affecting the hypophysis cerebri completes this part of the number.

DISCUSSION AND CORRESPONDENCE.

A DEFINITION OF FLUID.

In discussing Professor Elihu Thomson's paper on vulcanism Dr. Alfred C. Lane[1] asks: "Are we clear as to where we are to draw the line between viscous fluid and solid?" and he then gives a definition of fluid which is certainly an improvement on the old description of a fluid as a substance which will conform to the shape of the containing vessel and will present a level upper surface.

Dr. Lane's definition, however, does not answer the question: Where shall the line between solid and fluid be drawn? He cites molasses candy and tar as bodies which apparently are solids but which really are fluids; but he takes no account of the fact that it is changing conditions external to matter which determine the appearance and disappearance of many of its physical and chemical properties. At the temperature of liquid air both molasses candy and tar would lose the property of highly viscous fluidity, which they assume under the ordinary conditions whereunder we have become familiar with them, and would acquire a rigidity which would make them solids in the most approved sense. The place to draw the line between solid and fluid is at the junction of conditions which determine the supercession of the solid by the fluid state. This point was long ago recognized as a physical constant of matter and has received a name—plastic yield-point. This point, like melting-point, boiling-point and simple gas-point, separates two of the phases or states of aggregation through which matter passes in the course of its transformation from the highest to the lowest degree of polymerization.

Plastic yield-point, like melting-point and boiling-point, is a function of both temperature and pressure, and can, therefore, be represented graphically by a curve drawn with reference to temperature and pressure as rectangular coordinates. Under conditions fixed by a point on the curve of its plastic yield-point, a substance is on the dividing line between its solid and fluid phases. An increase of either temperature or pressure would (if a path be open) occasion molecular shearing—that is, differential motion between *molecules*—at any point in the mass. A decrease of either temperature or pressure would place the substance under conditions represented by the area on the other side of the curve, where the intermolecular locking is strong enough sensibly to resist (within the time considered) the force tending to make the molecules glide over one another; this is the distinctive property of solids. For all purposes of mechanics, including cases arising in dynamic geology, a fluid may be described as matter exposed to conditions which place it in the region beyond

[1] Science, N. S., Vol. XXIV., No. 613, p. 404.

the curve of its plastic yield-point in the direction of increasing temperature or pressure.

As to the internal constitutive differences which distinguish the fluid from the liquid state much remains to be learned, but it is regarded as probable that these differences are to a large extent grounded in a difference in molecular complexity; fluid and liquid doubtless bear to one another the same relation as vapor and gas, which usually always differ in molecular weight. Thus, sulphur vapor at 445° C. has the molecular formula S_8; as the temperature of this vapor is raised, the complex molecule S_8 undergoes a disintegration and finally becomes S_2, which is not broken up until the temperature has become very high. At a point which we may call the simple gas-point the complex molecules of the vapor phase give place to the simple molecules of the gas phase. Both boiling-point and simple gas-point vary with the temperature and pressure, and hence both may be represented graphically by curves. The vapor phase or condition will lie between these two curves, and such a phase is common to practically all substances that can be boiled.

Now when a solid is heated under atmospheric pressure it first softens and then melts; and this intermediate stage of softening, when the substance is neither solid nor liquid, is properly the fluid phase or state, comparable to the vapor phase which is intermediate between liquid and gas. It can hardly be doubted that in the solid phase the molecular weight is the largest possible. When the yield-point is attained, these large molecules just begin to break up into smaller units and this process is continued until the melting point is reached and the substance becomes a liquid; in this condition the molecular complexes are very stable, and, like the simple gas molecules, generally require large additions of energy to undergo further change.

OSWIN W. WILLCOX.

SANDY HOOK PROVING GROUND,
FORT HANCOCK, N. J.

WHY DO HERRING GULLS KILL THEIR YOUNG?

EARLY last July I was making for the Public Museum of Milwaukee a photographically recorded study of the actions of a colony of herring gulls covering Gravel Island, a little islet at the upper end of the Door County peninsula of Wisconsin. At the time of my visit the young of the year were mostly about half grown and usually kept by themselves in a flock of several hundred. There were always a few young scattered among the adults on the island, but the great majority were at all times to be found in the flock, which seemed to have taken to itself a definite habitat at one part of the islet.

The island is, I am told, visited with some degree of frequency by pleasure-seekers, though as it is fairly remote from any resort I do not fancy that these visits are very numerous in any one nesting season.

When first visiting the island I rowed out to it with two companions, pitched my tent in the center of the island and disappeared within, after which my companions returned to the boat and rowed away. I have reason to believe that my remaining among the gulls was not suspected by them. From various observations I am convinced that the individualities of the young were so hopelessly lost in the flock that they neither knew nor were known by their parents.

Almost from the beginning of my observations and continuing intermittently all through them I was witness of numerous attacks committed by adults upon the young, in which the latter were so severely wounded that death did or in a short time would ensue. At the time of my arrival this year and also when I visited the same colony a year ago the island was strewn with the bodies of some dozens of these half-grown gulls bearing evidence of having been similarly done to death.

Usually when my attention was attracted to the enactment of one of these tragedies the victim was a bird to which I had paid no previous attention; but there were several instances where the young had been under fairly close observation for some hours previous. In no instance could I see that the young was weak, sickly or in any way abnormal, nor that it had given offense for which it was being punished. Sometimes when the flock of young was on the water near the

island an adult would approach and seize a young on the outskirts of the flock. At other times attacks would be made on young just coming up the beach from the water, while several times those that for some hours had been unmolested near the center of the island were apparently without provocation set upon and left in a dying condition. The main point of attack was the back of the head. To this region a number of severe blows were given with the point of the bill, after which it was grasped between the mandibles of the adult and the bird was pulled about until the skin and flesh were cut through to the skull. Sometimes the young fell on its back with feet convulsively kicking in the air. In this position the carpal joint of the wing and the breast seemed to be the points at which blows were mainly aimed. If the young escaped by running or was left apparently lifeless but subsequently revived and made off during the absence of its persecutor it was at once attacked by any other adult that happened to be near.

I am unable to convince myself that this destruction of their young was due to molestation of the colony, as has been suggested to me, but I have no other explanation to offer, unless it be impatience at the toll of regurgitated fish that the young levy upon the old.

I wish to inquire whether this murderous action on the part of the herring gull or of other birds has been noted in other colonies and whether any plausible explanation of it can be given.

Henry L. Ward.
Public Museum, Milwaukee.

An Unusual Meteor.

To the Editor of Science: In connection with the sinuous trail left by the meteor described by E. E. Davis in your issue for August 3 and discussed by Professor Abbe in that for September 14, I might remark that a similar phenomenon was seen and sketched in the case of a fine meteor seen in Ontario on July 5, 1898, a full account of which is to be found in the *Transactions* of the Astronomical and Physical Society of Toronto for 1898, page 74.

C. A. Chant.
Toronto, October 16, 1906.

A Correction.

Mr. Bassler, of the U. S. National Museum, has called my attention to a serious error of mine on page 1,209, foot-note, of the Thirtieth Annual Report of the Indiana Department of Geology and Natural Resources. In discussing two species of corals, *Cystelasma rugosum* and *C. quinqueseptatum* Ulrich, figured and named, but without formal descriptions, by Mr. Ulrich in Professional Paper 36 of the United States Geological Survey, the foot-note states: 'These specimens are neither described nor do they have the internal structure shown.' The statement refers to both species instead of *C. rugosum*. It was intended to apply to *C. rugosum* but not to *C. quinqueseptatum*. As it is the statement is untrue, as the internal structure of *C. quinqueseptatum* is clearly and accurately shown in Mr. Ulrich's figures. This is a reflection upon Mr. Ulrich which was not intended and for which I wish to apologize.

The great accuracy with which Mr. Ulrich portrays the characters observed and his unusual powers of discrimination are well known and I would be the last one to question them, especially when I had not examined the specimens figured, as was the case in this instance. Printed slips will be sent to all those receiving copies of the separates of the paper ('Fauna of the Salem Limestone of Southern Indiana') in which the error occurs. Inasmuch as it is impossible to reach all those receiving the bound volumes, it will be a favor if those having them will note the correction in the book.

J. W. Beede.

Special Articles.

A New Artemia and its Life Conditions.

The classic observations and experiments of Schmankewitsch thirty years ago on the *Artemias* of certain salt pools near Odessa (Russia) clothe this curious phyllopod genus with a peculiar interest to zoologists and to students of species-forming. This interest has been renewed by the occasional reconsideration of Schmankewitch's data, and more rarely by the actual reexamination of *Artemia*

individuals under different environmental conditions (primarily the varying density or salt concentration of the waters in which the creatures live). In 1898 Anikin determined, to his own satisfaction at least, that the structural changes induced in *Artemia* individuals of succeeding generations by rearing these generations in salt water of differing density were not true species differences, fixed and heritable, but simply ontogenetic differences maintained only as long as the particular inducing influences (denser or less dense salt water) persisted. Certain specific characters, particularly those of the male, did not change at all, so that Anikin believed himself to be able still to recognize his original species throughout all the generations grown under modified conditions, although the species was actually plainly modified in structure in certain particulars. These structural changes, however, he found could be avoided if the changes in environment were made very gradually. When made violently the changes were marked, and could perhaps be interpreted to be those of degenerative or arrestative modification. In other words, the rearing of young in a salt water of higher concentration than that normal to the species worked injury or arrestation in the development. These modifications as noted by both Schmankewitsch and Anikin were chiefly concerned with the segmenting of the abdomen and the length and hairiness of the caudal appendages. As differences in exactly these characters were those by which the European species of *Artemia* (and partly the genus *Branchipus*) were distinguished, it is not surprising that Schmankewitsch believed himself to see *Artemia salina* transform into *A. milhausenii*, and *vice versa;* and even the genus *Artemia* change to the genus *Branchipus*. However, the correct interpretation of the affair is, probably, that the original describers of the European species had before them various 'ontogenetic species' of *Artemia, i. e.,* nutritional or developmental varieties.

In America three species of *Artemia* have been recognized; one *A. gracilis* Verrill, from barrels or casks of salt marsh water exposed (and hence much denser than the original marsh water) on a railroad bridge near New Haven, Conn.; another, *A. fertilis* Verrill, from Great Salt Lake, and the third, *A. monica* Verrill, from Mono Lake, Cal., a strongly salt and alkaline lake in the Owens River desert. All of these *Artemias* are living in salt water of a density much greater than that of ordinary sea water. The water in the New Haven casks varied in density from 1.06 to 1.065; the water in Great Salt Lake has a density of 1.17 and that in Mono Lake is certainly not less dense and is "so alkaline that it is said to be used for removing grease from clothing. It is said to contain, also, biborate of soda." I know of no experiments with the American *Artemias* except that Verrill states that *A. gracilis* 'can exist without apparent inconvenience when the water in which they occur is diluted with an equal bulk of fresh water as well as when it is much concentrated by evaporation.'

To the short list of American species I have to add a new one collected by student David Fulloway from the evaporating pools of a salt works at Redwood City (five miles from Stanford University) on the west shore of San Francisco Bay. This west coast *Artemia* differs markedly from the other American species in those characteristics upon which Verrill relies to distinguish the already known American forms, viz., the shape of the male claspers, the female egg-sac, and the character of the caudal appendages. The character of size upon which Verrill seems to have placed some reliance is a frail support, for it gives way when individuals reared under different conditions (density of salt water) are compared. The new species may be named and described as follows:

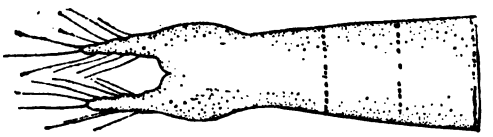

FIG. 1. Posterior tip of abdomen, showing caudal appendages of male *Artemia franciscana*, n. sp.

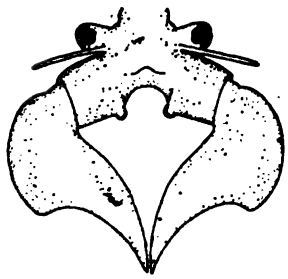

FIG. 2. Front aspect of head of male *Artemia franciscana*, n. sp., showing eyes, antennæ and claspers.

Artemia franciscana n. sp. (Figs. 1 and 2). Body slender; length of mature females (with eggs) from 6 mm. to 13 mm., males 5 mm. to 8.5 mm.; color translucent whitish to dull brick-red; claspers of male with stout median part and elongate, regularly tapering acute-angled terminal part; the suture between second and third segments is wholly lacking (this condition practically breaking down the distinction between the genus *Artemia* and the genus *Branchipus*), and there is no indication by external angle or change in direction of the outer or inner margins to indicate the point of fusion of these two segments (Fig. 1); egg-sac of female as broad as long; caudal appendages longer than broad, longer than in any of the other three known American species, and with scattered hairs all along both sides of each appendage (this character also tends to approach the condition in *Branchipus*). This species in a way serves to connect the genera *Branchipus* and *Artemia* but in all its general habitus and in the shape (very characteristic) of the claspers of the male it is much nearer the described *Artemia* forms than the *Branchipus* type. Males, females, eggs and larval stages found abundantly in the salterns (evaporating pools), density 1.08 to 1.24, at Redwood City, San Francisco Bay, in September, 1906.

As mentioned in the species description, mature specimens, both males and females, of this *Artemia* vary markedly in size and coloration. They vary also in degree of activity. All these differences are plainly correlated with the different life-conditions of the creatures. The water of San Francisco Bay has a density of 1.024. Pools of evaporating salt solution of the following densities were examined: 1.06, 1.085, 1.11, 1.137, 1.187, 1.19, 1.20, 1.207, 1.23, 1.24. Beyond this density the salt is precipitating rapidly. *Artemias* occur in all these pools from 1.08 on, most abundant, largest and most active, however, in water of 1.11 and 1.13. In water of less density than 1.11 the *Artemias* are large but not so abundant; in water of greater density they are noticeably smaller, and in the densities of 1.20 and upward they are much smaller and much less active. The color variation is also associated with the density, both males and females in the denser pools being reddish, the females alone reddish in the waters of medium density, and both males and females translucent whitish in the pools of 1.085, 1.11 and 1.137. In water of 1.24 (in which the salt is precipitating slowly) there are not many *Artemias* and they are all reddish, very small and noticeably inactive.

With special reference to the differences which Schmankewitsch and Anikin found among individuals of *Artemia salina* grown in salt solutions of various densities I may confine myself, at present (pending the outcome of more systematic observation and experimentation), to the statement that differences in proportional length of post-abdomen to rest of body, in character of the abdominal segmentation and in length and hairiness of the caudal appendages are apparent in this new *Artemia* and evidently bear a definite relation to the different densities of the pools in which the *Artemias* are living.

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SOME UNUSUAL NEW JERSEY FISHES.

DURING the past summer Mr. Wm. J. Fox was located at Sea Isle City, N. J., and observed or obtained the following species: *Lamna cornubica, Galeocerdo tigrinus, Myliobatis freminvillii, Clupanodon oglinum, Lucania parva, Tylosurus raphidoma, Hemiramphus brasiliensis, Albacora thynnus, Seriola lalandi, Blepharichthys crinitus, Vomer setapinnis, Palinurichthys perciformis, Bairdiella chrysura, Chætodipterus faber, Pomacanthus arcuatus, Balistes carolinensis, Alutera schœpfii* and *Echeneis alba-cauda*. A fine example of *Istiophorus nigricans* was also secured. *Stephanolepis hispidus* and *Ortho-*

pristis chrysopterus were taken at Palermo, in Cape May County, by Mr. George Z. Hartman, and at Cape May Mr. H. Walker Hand reports *Lagodon rhomboides* and *Limanda ferruginea*.

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ACADEMY OF NATURAL SCIENCES OF PHILA.

QUOTATIONS.

'BOTANY IN ENGLAND.'

PROFESSOR F. W. OLIVER'S presidential address to the botanical section of the British Association consisted of two parts, one dealing with 'The Seed, a Chapter in Evolution,' the other with 'Botany in England.' With the former we do not propose to deal; but the latter raises so many points for discussion that we can not but wonder that Professor Oliver selected for its delivery an opportunity when discussion was impossible. Although headed 'Botany in England,' it is mainly occupied with an attack upon the two great public herbaria—which, in Professor Oliver's opinion, 'stand apart from the ordinary botanical current,' and must consequently 'languish' or suffer 'atrophy through disuse.'

Professor Oliver's style is not easy to follow, and we sometimes find it difficult to grasp his meaning. We propose, however, to offer a few remarks upon some of his statements, premising that we do not admit his claim to act as a judge in matters with which it is abundantly evident he is but imperfectly acquainted.

Having given a very brief sketch of what he considers 'the prevailing school of botany,' Professor Oliver proceeds to inform us that it 'has arisen very independently of that which preceded it.' Here we must at once join issue with him. He continues: 'All through the middle parts of the last century we were so busy amassing and classifying plants that the great questions of botanical policy were left to solve themselves.' Yet this period included the morphological work of Robert Brown, Lindley and Sir Joseph Hooker, not to mention that of Carruthers and W. C. Williamson, who were largely instrumental in establishing the science of paleobotany, and without whose work the first part of Professor Oliver's address would hardly have been written. In view of the above references, can it be said with any degree of accuracy that 'the prevailing school of botany has arisen very independently of that which preceded it?'

Professor Oliver continues:

> Great herbaria became of the order of things; they received government recognition, and they continue their work apart. Those who built up these great collections neglected to convince the schools of the importance of training a generation of botanists that would use them. The schools were free, and they have gone their own way, and that way does not lie in the direction of the systematic botany of the herbarium. So long as this tendency prevails, the herbaria must languish. When I say languish, I do not mean that they will suffer from inefficient administration—their efficiency probably has never been greater than at the present time. But the effort involved in their construction and up-keep is altogether disproportionate to any service to which they are put. * * * If things are left to take their course there is the fear of atrophy through disuse.

It is not easy to understand what Professor Oliver means in the first portion of this paragraph. The main function of 'the schools,' as it appears to us, is not to train a generation of botanists to use herbaria, but to impart a general knowledge of the subject which will enable the student to follow up any line which may have a special attraction for him, including, of course, systematic botany. But the flourishing existence of herbaria depends very little upon 'the schools.' The students of botany both at the British Museum and at Kew are sufficiently numerous to show that Professor Oliver's fear of 'atrophy through disuse' is groundless, although according to him these herbaria 'stand apart from the ordinary botanical current.' Whatever may have been 'the effort involved in their construction,' it is a thing of the past, and its proportion or disproportion to the 'service to which they are put' can not be discussed: their 'efficiency,' he admits, was 'never greater than at present.' It may be that besides the 'ordinary botanical current' with which Professor Oliver is acquainted, there is another of whose course he is ignorant.

Having, however, satisfied himself that the 'general position of systematic botany' re-

quires 'alleviation,' and that atrophy is imminent, the professor proceeds to 'attempt an analysis of some of the causes which have led to this condition of affairs.' Neither the British Museum nor Kew "has any connection, direct or indirect, with any university organization; there are no facilities for teaching; there are no students; no machinery exists for training recruits or for interesting anybody in the ideals and methods of systematic botany." If by this Professor Oliver means that herbaria are not teaching bodies in the sense that a university is, he is accurate enough; but when he proceeds to argue as a consequence that there are no means for interesting folk in systematic botany, he evidently speaks in ignorance of what can be and is being done. As regards the national herbarium, of which we are in a position to speak, it would not be difficult to find systematists of European reputation who would acknowledge with gratitude the help they have received in acquiring a knowledge of 'the ideals and methods of systematic botany'; and we have no doubt that similar testimony could be given at Kew. To take one example from each—Mrs. Gepp, who has a world-wide reputation as an algologist, owes her position to the 'ideals and methods' acquired as a student in the department of botany; Mr. Hiern, whose monograph of Ebenaceæ (1873) was but the first of a long series of contributions to systematic botany, first became 'interested' at Kew, and has since, at both herbaria, availed himself of the 'facilities'—for learning if not for teaching—which they afford.

Professor Oliver then goes on to suggest "another way in which a great economy could be effected in effort, time and money; this is the transfer of the collections and staff of the botanical department from the Museum to Kew. This is a very old proposal, first seriously entertained some fifty years ago after the death of Robert Brown." It may be remarked *en passant* that this 'old proposal' was first made in the course of Brown's own evidence before the Royal Commission on the British Museum in 1848, and rebutted by him (Q. 3468–9). "There must," he continues, "be endless files of reports and blue books in official pigeon-holes dealing with this question." This, of course, is pure hypothesis. "The most recent report of a departmental committee is known to all interested in the matter. From the character of the evidence tendered it is not surprising that no action has been taken." Professor Oliver must know that the 'evidence' was tendered by men of qualifications at least equal to his own—men, moreover, acquainted, as he manifestly is not, with the work and functions of a herbarium; and that if 'no action was taken' it was because none seemed desirable. This, however, does not prevent an *ipse dixit* which at any rate shows that the professor will allow no undue modesty to hinder the expression of his opinion: 'I am at a loss to find any adequate reason for the maintenance of two separate herbaria.' We have no intention of entering upon a discussion of the matter; suffice it to say that those best acquainted with both collections have long been of the contrary opinion, and that that opinion is strengthened as their knowledge increases. We note that in contemplating the fusion, Professor Oliver assumes that this would be done by the transfer of the museum collections to Kew; but his acquaintance with the report of the departmental committee to which reference has been made will have shown him that the reverse process has been advocated, and in view of his hope for an alliance of the herbarium officials with a 'local university,' it would seem a more reasonable plan.

It is clear from the whole tenor of his remarks that Professor Oliver is unacquainted with the functions or the value of public herbaria, and it is only when we recognize this that his position becomes intelligible. His ignorance is the more remarkable considering the eminent position as a systematic botanist attained by his father when keeper of the Kew Herbarium; but it is obvious when, for example, he tells us that 'in the long run it may be that our present collections will prove obsolete,' and adds significantly, 'the scrap-heap is the sign and measure of all progress.' He does not understand that a public herbarium

fulfills a variety of purposes with which the 'schools' have, and can have, nothing to do. At the national herbarium, for example, the botanical history of the last two or three hundred years can be traced; the types of Linnean species, of the early American collectors, and the great Sloane Herbarium are therein preserved; and so far from showing any signs of becoming 'obsolete,' they are constantly consulted by botanists from all parts of the world, both by personal visits and by correspondence. Apart from these, the student of the British flora, the amateur botanist, the horticulturist, the elementary teacher and the intelligent inquirer find the herbarium a convenient center for prosecuting their studies, and for obtaining information which they could not readily obtain elsewhere. If Professor Oliver's ideal were realized, botany would become the sole possession of the schools; and not only the foreign systematist, but the general public, the private student, the amateur and the monographer would be excluded from consideration. The national herbarium and that at Kew are supported by public funds; it is, therefore, manifestly but common justice that the public, rather than the schools, should have the prior claim to their services.

The fact is that Professor Oliver looks at botany exclusively from his own somewhat narrow standpoint—that of a successful and capable teacher obsessed by the notion that teaching is the only thing worth troubling about. For this purpose there must be an alliance between the authorities of the herbaria and the 'local university'; for 'directly you give the keepers or assistants in the former a status in the latter, you place at the disposal of the systematists a considerable supply of recruits in the form of advanced students possessing the requisite training to carry out investigations under direction.' But where are these students to find employment? If the fusion of the two herbaria to which he looks forward would effect 'a great economy in effort, time and money,' it would seem that the openings for trained students would have to be reduced rather than increased.

Professor Oliver has not adduced convincing evidence of the organizing capacity of 'the local university,' or of the desirability of entrusting to it, or to 'the schools,' the sole management of botanical affairs. The London University, for example, has recently been severely criticized in the daily press for the mismanagement and neglect of the valuable libraries entrusted to its charge. The *Tribune* of August 16, says:

> The university, when it migrated from Burlington Gardens to its present quarters, had two magnificent collections of books—the 'Grote' and the 'De Morgan,' besides a considerable accumulation gathered at various times. When the removal took place the books were conveyed in trolleys by workmen, 'dumped down' anywhere, and allowed to remain in the utmost confusion exposed to great risk and damage. Rare editions were actually found later on at the bottom of the lift-hold in a pool of water. Books lay about in rooms where committees sat; any one who took a fancy to a volume carried it off, entering his name, and the name of the author, if he were very scrupulous, in a little washing-book. A porter was librarian, and the lift-boy sublibrarian. At one time it was proposed to make a subject-catalogue, and a former official of the university began to carry out the scheme on slips of paper, as he rode to and from his work on the omnibus. His notes have been preserved as a curiosity. He catalogued a famous antiquarian work on 'Seals' under 'Zoology.'

May it not be asked whether the universities or 'the schools' have done more for the advancement of 'botany in England' than men like Robert Brown and Sir Joseph Hooker, whose work was unconnected with either? Is it not the case that at the present time botany in our oldest university finds its most active exponent in the person of an amateur systematist?

One lesson which may be gathered from Professor Oliver's onslaught is the extreme importance of retaining the national herbarium under the management of trustees One shudders to think what would happen were it handed over to the tender mercies of men of his stamp, or to some purely bureaucratic body. This danger was pointed out by the

Westminster Gazette in its account of the British Association meeting:

> It is interesting to note the dangers to a scientific institution directly under our bureaucracy when Professor Oliver, in his address this morning to the botanical section, actually urges that the British Museum botanical collections should be transferred from the enlightened charge of the independent trustees to Kew, which is under the board of works. If government is to advance the pursuit of scientific research by subsidies, it must be content to entrust the disposal of these subsidies to boards of independent men.

It seems to us that, of course unconsciously, he has supplied a weighty argument in favor of retaining the two herbaria, so that if at one the 'dead Welwitschia' should be ousted by the 'live dandelion,' the former may yet be retained in safe custody for the benefit of future students.

Much more might be said did space allow. It would be possible, for instance, to show more fully what has already been indicated—namely, that Professor Oliver is hardly qualified, either by knowledge or by position, to pronounce judgment upon matters as to which older if not wiser men have expressed very different opinions. We think that, on reflection, he will regret that he introduced what was felt by many who heard it to be an element of discord into an assembly of botanists from all parts of the country. 'He is evidently,' as Bentham said of Naegeli, 'a man of great ability and zeal, and a constant and hard worker'; and we can only hope that increasing years will enable him to take broader views, and at least to recognize that his individual standpoint is not the only one, and need not necessarily be the best.

James Britten.

Note.—The death of Mr. C. B. Clarke since the above was written suggests the mention of him as one who was in no sense a creation of 'the schools,' and whose name will always be associated with Kew, where he did most of his work, and with the national herbarium, to which he was a frequent and welcome visitor. —*The Journal of Botany.*

Current Notes on Meteorology.

The Monthly Weather Review.

The July, 1906, number of the *Monthly Weather Review* (dated October 11) contains the following papers:

'The Waterspout seen off Cottage City, Mass., on Vineyard Sound, on August 19, 1896,' by Professor F. H. Bigelow. This is one of a series of papers on the thermodynamics of the atmosphere, and is the most complete discussion of a waterspout which we have ever seen. Several excellent half-tones are given. An early notice of this waterspout and of some of the photographs here reproduced was included in these notes in Science, N. S., Vol. IV., 1896, 718–719. Professor Bigelow has made a careful study of all the available accounts of this waterspout, and has made calculations as to its dimensions.

'Climatology of Porto Rico from 1867 to 1905, inclusive,' by W. H. Alexander. Mr. Alexander has already contributed other studies of West Indian climatology. The present paper contains numerous tables of climatological data which will be valuable to any one who seeks information regarding Porto Rican climate.

'Snow Rollers,' by Wilson A. Bentley. Mr. Bentley's name is well known in connection with his remarkable studies of snow crystals by micro-photography. The present article deals with the formation of 'snow rollers' at Jericho, Vt., on January 18, 1906, and is illustrated by means of two half-tones. 'Snow Rollers at Mount Pleasant, Mich.,' by Professor R. D. Calkins, is another study of a similar occurrence, at a different place.

Mammato-cumulus clouds.

The September, 1906, number of the *Meteorologische Zeitschrift* contains a study of mammato-cumulus clouds by H. Osthoff, with some illustrations reproduced from drawings. In all, sixty-seven observations of this peculiar cloud form were made by the writer, the majority being in summer and during the warmer hours. A rapid disappearance of the cloud was noted as characteristic, the form being a passing stage of an existing cloud.

The writer believes that the probable cause of the mammato-cumulus is to be found in a descending air movement, which, however, in view of its usually being very limited in area, seldom reaches down to the lowest air strata.

BIRD MIGRATION AND WEATHER IN HUNGARY.

THE spring dates of arrival in Hungary of migrating birds have been studied in relation to weather conditions for the period 1894–1903, by J. Hegyfoky, who presents the general results in the September number of the *Meteorologische Zeitschrift*. Weather which is warm and pleasant accelerates the arrival of the birds, while unpleasant cool weather delays their coming. When high pressures prevail over the continent the arrival is regular, but when depressions, of short duration, occur, the arrival is irregular.

NOTES.

J. R. SUTTON, meteorologist of the De Beers Consolidated Mines at Kimberley, continues his valuable discussions of the meteorology of the South African table-land in a paper on 'The Climate of East London, Cape Colony' (*Trans. So. Afr. Phil. Soc.*, XVI., 3, August, 1906).

R. DEC. WARD.

BOTANICAL NOTES.

PAPERS ON FUNGI.

TWO years ago Dr. G. P. Clinton, of the Connecticut Experiment Station, published a very helpful monograph of the North American *Ustilagineae* (*Proc. Boston Society Nat. Hist.*, Vol. 31) which was noticed in this journal (SCIENCE, July 7, 1905). The same author has published another paper on the same group of plants, but for a restricted area under the title, 'The Ustilagineae, or Smuts, of Connecticut.' It constitutes Bulletin No. 3 of the State Geological and Natural History Survey, and includes forty-four pages of text and seven full-page plates. There is first an introduction of seven pages in which the general characters, life history and economic importance of the smuts are discussed, and this is followed by a systematic key to the genera, of which there are twelve represented by species in the state. Under each genus, after its characterization there is a key to the species with the specific descriptions clearly drawn. No synonyms are included, but hosts and localities are given with much fulness. In all, forty-nine species and one variety are described. The plates (mostly half-tones) add much to the usefulness of the paper.

In 'A Preliminary Report of the Hymeniales of Connecticut' Professor Edward A. White published (in Bulletin 3 of the State Geol. and Nat. Hist. Survey) the results of his studies of the larger fungi (mainly toadstools and pore-fungi) of Connecticut. It constitutes a thick pamphlet of eighty-two pages of text, and forty excellent half-tone plates of photographs. As stated in the preface, the author's aim 'has been to compile as far as possible a complete and accurate list of native species, together with notes regarding the characteristic genera.' This plan has been so carried out that one finds here clear, non-technical descriptions of fifty-five genera, aided by the very good plates, and following each generic characterization is a list of the species with localities and notes in regard to edibility. There are enumerated of *Agaricaceae* 233 species, *Polyporaceae* 103, *Hydnaceae* 23, *Thelephoraceae* 18 and *Clavariaceae* 11. This pamphlet should prove useful to beginners in the study of the larger fungi in Connecticut, as by it the genus of any specimen can be determined, and that is all that the beginner should attempt. The identification of species may well be deferred until genera are pretty well fixed in mind.

Professor Doctor Arthur contributes to the volume 'Resultats scientifiques de Congrès international de Botanique Vienne 1905' a paper on the classification of the *Uredineae* based upon their structure and development ('Eine auf die Struktur und Entwicklungsgeschichte begründete Klassifikation der Uredineen'), in which he proposed an entirely new arrangement of the group. He divides the order *Uredinales* into three families, viz., *Coleosporaceae*, with seven genera (*e. g.*, *Coleosporium*, *Chrysospora*, etc.) representing three subfamilies; *Uredinaceae*, with twenty-

two genera (*e. g., Pucciniastrum, Chrysomyxa, Uredo, Cronartium, Endophyllum,* etc.) representing four subfamilies; and *Aecidiaceae,* with thirty-five genera (*e. g., Ravenelia, Uropyxis, Phragmidium, Aecidium* (*Gymnosporangium*), *Dicaeoma,* etc.) representing five subfamilies. The old genus *Uromyces* is split into *Nigredo, Uromycopsis, Klebahnia* and *Telospora,* while *Puccinia* is split into *Dicaeoma, Allodus, Bullaria* and *Dasyspora.* We hope to present a fuller account of this interesting study in the near future.

Dr. Arthur and F. D. Kern have published (in *Bull. Torr. Bot. Club,* vol. 33) a paper on the 'North American Species of *Peridermium,*' of form-genus of *Uredineae* inhabiting conifers. The authors distribute the species of *Peridermium* among the following actual genera: *Coleosporium* and *Cronartium* (on *Pinus*), *Pucciniastrum* and *Calyptospora* (on *Abies, Tsuga* and *Ephedra*), *Melampsorella* and *Melampsoridium* (on *Abies* and *Larix*) and '*Chrysomyxa*' (on *Picea* and *Abies*).

CALIFORNIA TREES.

About a year ago Alice Eastwood issued 'A Handbook of the Trees of California' as one of the 'Occasional Papers' (IX.) of the California Academy of Sciences. In a thick pamphlet of 86 pages and 57 plates she has given such a popular account of the trees of California as must prove of great use to the botanical students of the Pacific coast. It will be useful also to botanists elsewhere, since it brings together in convenient form the names and descriptions of the trees known to be native of that region. In all, the author includes 134 species, of which 42 are Gymnosperms. There is but one species of palm and two Yuccas. Of other common genera there are of willows (*Salix*) 11 species, *Populus* 3, *Juglans* 1, *Betula* 1, *Alnus* 3, *Quercus* 13, *Celtis* 1, *Crataegus* 2, *Acer* 4 and *Fraxinus* 3. The state has no native elms, magnolias, lindens, beeches, hickories, chestnuts, persimmons, nor mulberries, but it has in the Madroño (*Arbutus menziesii*) and the California laurel (*Umbellularia californica*) two most interesting trees which go far towards making up for the loss of the former.

An especial interest attaches to this volume because it is one of the last issued by the California Academy of Sciences before its destruction by earthquake and fire, and still more because of the heroism of the author (who is also the botanical curator) through whose faithfulness and bravery some of the collections were saved. Such great devotion to duty, and entire indifference to personal danger as she displayed in the most terrifying experiences compel our highest admiration.

Charles E. Bessey.
The University of Nebraska.

DEGREES CONFERRED BY THE UNIVERSITY OF ABERDEEN.

Among the large number of doctorates of law conferred by the University of Aberdeen on the occasion of its recent quatercentenary, *Nature* selects the following as especially concerned with science:

Richard Anschutz, professor of chemistry, Bonn; Henri Becquerel, professor of physics, Paris; Sir James Crichton-Browne, Kt., Lord Chancelor's visitor in lunacy; Casimir de Candolle, Geneva; Frank Wigglesworth Clarke, chief chemist, U. S. Geological Survey, Washington; Yves Delage, professor of zoology and comparative anatomy, Paris; J. Deniker, librarian of the Museum of Natural History, Paris; W. Einthoven, professor of physiology, Leyden; Herbert Mackay Ellis, director-general, Naval Medical Service, London; Arthur J. Evans, keeper of the Ashmolean Museum, Oxford; Andrew Russell Forsyth, Sadlerian professor of pure mathematics, Cambridge; Sir Archibald Geikie, secretary to Royal Society; Arnold Hague, U. S. Geological Survey, Washington; H. J. Hamburger, professor of physiology, Groningen; Edward Hjelt, professor of chemistry, Helsingfors; Harald Höffding, professor of philosophy, Copenhagen; Ferdinand Hueppe, professor of hygiene, Prague; Howard A. Kelly, professor of gynecology, Johns Hopkins University, Baltimore; Surgeon-General Sir Alfred Keogh, K.C.B., director-general, Army Medical Service; Rudolf E. Kobert, professor of pharmacology,

Rostock; Casimir Kostanecki, professor of anatomy, Cracow; Hugo Kronecker, professor of physiology, Bern; Sir Francis H. Laking, Bart., G.C.V.O., physician in ordinary to His Majesty the King and the Prince of Wales; Commandatore Rodolfo Lanciani, professor of ancient topography, University of Rome; Charles Rockwell Lanman, professor of Sanskrit, Harvard University; Gustavus Mittag-Leffler, professor of mathematics, Stockholm; Oscar Liebreich, professor of pharmacology, Berlin; Sir Norman Lockyer, K.C.B., director of Solar Physics Laboratory, South Kensington; Sir Oliver Lodge, Kt., principal of Birmingham University; Friedrich Löffler, professor of hygiene, Greifswald; Donald Macalister, president, General Medical Council; A. B. Macallum, professor of physiology, Toronto; Sir John Macfadyean, principal of the Royal Veterinary College, Camden Town, London, N.W.; Lord M'Laren, vice-president, Royal Society of Edinburgh; Jinzo Matsumura, professor of botany, University of Tokyo, Japan; His Serene Highness Albert Honore Charles, Prince of Monaco; Wilhelm Ostwald, professor of chemistry, Leipzig; Edmund Owen, vice-president, Royal College of Surgeons of London; W. M. Flinders Petrie, professor of Egyptology, University College, London; Rev. George E. Post, professor of surgery in Johanite Hospital, Beirut; Sir Richard Douglas Powell, Bart., K.C.V.O., president of the Royal College of Physicians, London; Salomon Reinach, professor of archeology, Paris; Guglielmo Romiti, professor of anatomy, Pisa; Sir Henry E. Roscoe, late professor of chemistry, Owens College, Victoria University; Major Ronald Ross, C.B., Liverpool School of Tropical Medicine; Vladimir Scheviakoff, professor of zoology, St. Petersburg; Jakob Schipper, professor of English philology, Vienna; Dukinfield Henry Scott, hon. keeper, Jodrell Laboratory, Kew Gardens; William Napier Shaw, director of the Meteorological Office, London; Joseph J. Thomson, Cavendish professor of experimental physics, University of Cambridge; Frederick Trendelenburg, professor of surgery, University of Leipzig; Sir William Turner, K.C.B., principal of University of Edinburgh; Giuseppe Veronese, professor of analytical geometry, Padua; Hugo de Vries, professor of physiological botany, Amsterdam; J. William White, professor of surgery, Pennsylvania University; J. W. van Wijhe, professor of anatomy, Groningen, Holland; Sir John Williams, Bart., K.C.V.O., late professor of midwifery, University College, London.

THE FRANCO-AMERICAN EXPEDITION TO EXPLORE THE ATMOSPHERE IN THE TROPICS.

THE third cruise of the *Otaria*, the steam-yacht sent by M. Teisserenc de Bort, director of the private meteorological observatory at Trappes, near Paris, and by Mr. Rotch, director of the similar observatory at Blue Hill, near Boston, to explore the atmosphere over the tropical Atlantic has ended, and the yacht has returned to Havre after a very successful voyage of three months and a half.

Atmospheric soundings with balloons and kites were executed over the central part of the North Atlantic, the equatorial regions and the South Atlantic as far as Ascension Island. The soundings southwest and northwest of the Canaries confirm the conclusions reached during the two preceding cruises of the *Otaria*, namely, that the upper anti-trade blows from southeast or southwest, not only within the tropics but generally as far north as latitude 30°, and is found above the open ocean as well as above the Canaries. Farther north it is transformed into a westerly wind.

The observations with *ballons-sondes* revealed this new and important fact, that in summer over the equator, very low temperatures (reaching — 80° C.) exist in the upper air above 12 kilometers, being analogous to those occurring in winter at the same height in our own latitude.

SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.

A PUBLIC meeting will be held at Cooper Union on Friday evening, November 16, at eight o'clock, under the auspices of the national Society for the Promotion of Industrial Education.

Mr. Milton P. Higgins, president of the organization committee, will introduce Dr. Henry S. Pritchett, president of the Massachusetts Institute of Technology, who will preside, and the following speakers will address the meeting:

Mr. Frank A. Vanderlip, vice-president of the National City Bank, 'Competition of the United States in the Markets of the World.'

Mr. Frederick P. Fish, president of the American Telephone and Telegraph Company, 'Industrial Education as a Means of Developing the Industries of the United States.'

Miss Jane Addams, Hull House, Chicago, 'The Importance of Industrial Education from the Social Standpoint.'

Dr. Nicholas Murray Butler, president of Columbia University, 'The Place of Industrial Education in the American System of Education.'

Mr. Frank P. Sargent, U. S. Commissioner-General of Immigration, formerly chief of Brotherhood of Locomotive Firemen, 'The Importance of Industrial Education to the Workingman.'

An address will also be made by Mr. Alfred Mosely, of London, and a letter from President Roosevelt upon the subject of the meeting will be read.

A meeting for the purpose of effecting a permanent organization will be held in room 19, Cooper Union, at 4 P.M., on the same day. All interested in the purposes of the organization are invited to attend this meeting as well as the evening meeting.

SCIENTIFIC NOTES AND NEWS.

ADVANTAGE will be taken of the twentieth anniversary of the isolation of fluorine to present a gold medal to M. Moissan.

IN acknowledgment of his work in metallurgical research, Professor Henry M. Howe, of Columbia University, has received from the Russian emperor the order of the Knighthood of St. Stanislas. The honor was conferred by Baron Rosen, who gave the patent of knighthood, together with the star and cross of the order.

PRESIDENT ROOSEVELT has reappointed Dr. Robert M. O'Reilly to serve a second term of four years as Surgeon-General of the United States Army.

A FAREWELL banquet was given recently in honor of Sir David Gill, the astronomer royal at the Cape, who left for England on October 3.

THE University of Durham has conferred the degree of D.Sc. on Sir William White, lately director of naval construction and assistant controller of the royal navy; on Professor G. A. L. Lebour, professor of geology and vice-principal of Armstrong College, Newcastle-on-Tyne; on Mr. Charles A. Harrison, engineer to the Northeastern Railway Company, and on Mr. G. B. Hunter, shipbuilder.

CAPTAIN AMUNDSEN, who has recently returned from navigating the northwest passage, is at present in this country. He has been entertained recently by the Geographical Society of Chicago.

DR. HENRY S. PRITCHETT, president of the Carnegie Foundation for the Advancement of Teaching, will give the address at the decennial founder's day exercises of the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y.

A NEW wing of the Acland Home, Oxford, containing operating, sterilizing and anesthetic rooms, with open-air balconies, was opened by Professor Osler on October 13.

DR. CH. WARDELL STILES, of the Public Health and Marine Hospital Service, has been withdrawn from the commission which has been appointed to make a new commercial treaty with Germany.

M. HENRI DE ROTHSCHILD has given 20,000 fr. to Professor Poirier for the study of cancer.

PROFESSOR W. SOMERVILLE (M.A. Cant.), Sibthorpian professor of agriculture at Oxford University, has been elected to a fellowship at St. John's College.

THE Gedge prize, Cambridge University, has been awarded to Mr. P. P. Laidlaw, for an essay entitled 'Some Observations on Blood Pigments.'

DR. M. I. PUPIN, professor of electromechanics at Columbia University, was a can-

didate for the Connecticut General Assembly from Norfolk, but was defeated.

PROFESSOR T. C. BEILSTEIN, professor of chemistry in the St. Petersburg Technological Institute, well known for his work in organic chemistry, especially for his work on the aromatic series, died on October 19, at the age of sixty-eight years.

THERE will be a civil service examination on November 14 for laboratory assistant, qualified in optics, in the Bureau of Standards at a salary of $1,000, and on November 27 and 28 for the position of assistant chemist in the Bureau of Chemistry, Department of Agriculture, at a salary of $1,800.

A FIRE in the power room of the Carnegie Institute, Pittsburg, on November 4, damaged the building, according to the daily papers, to the extent of $10,000.

IN view of the devastation caused by the sleeping sickness among the natives of certain districts of the Congo Free State, as well as among Europeans residing there, the king of Belgium has offered a prize of 200,000 francs to any person of any nationality who shall discover a cure for the said sickness, and also an additional sum of 300,000 francs for the purpose of making researches and experiments toward exterminating the plague.

THE Boston *Transcript* states that the Princeton archeological expedition to Syria has presented to the imperial Ottoman museum in Constantinople a mosaic pavement which was discovered by the expedition when it was in Jerusalem two years ago. Professor Howard Crosby Butler, who with Professor W. K. Prentice, Dr. Enno Littman and Frederick A. Norris composed the expedition sent out by Princeton, has returned from Constantinople, where during the past summer he superintended the laying of the mosaic in a position of honor in the new wing of the imperial museum.

ACCORDING to the *Journal of the American Medical Association* it is said that the Carnegie Institution is considering the discontinuance of the *Index Medicus* on account of lack of financial support.

A NUMBER of specimens of U. S. government standard teas, together with illustrations of the plant and descriptions of the process of tea-making, have recently been acquired by the Botanical Museum of Harvard University. A collection of prehistoric grains, with several specimens of fruits and bread, which were completely charred in the conflagrations by which the lake dwellings of the stone and bronze ages were destroyed, are also on exhibition. Seventy illustrations of a few wild flowers from the eastern United States, painted by Mrs. C. D. Murdoch, and specimens of 'Silver Sword' collected from the brink of the volcano Holeakala, Mani, Hawaiian Islands, have also been acquired.

THE trustees of the British Museum have just issued the fifth edition of the 'List of casts of fossils reproduced chiefly from specimens in the department of geology,' and a copy can be obtained on application to the director of the British Museum (Natural History). Compared with the fourth edition this list has nearly double the number of pages and gives particulars of no less than 800 plaster casts, which can now be procured by purchase or exchange. Most of these are of fossil vertebrates, among which we notice several of the highly interesting mammals recently discovered in the Fayum by Dr. C. W. Andrews. A model of the skull of *Phororhacos longissimus* has been added to the birds, while among the reptiles are some of the South African forms described by Seeley. Among invertebrates are casts of many of Sowerby's types of ammonites, and the type-specimens of many echinoderms. The list also offers for £5 a colored model of the Greenland Right Whale (*Balaena mysticetus*), scale one inch to one foot, made under the superintendence of Captain David Gray, S. S. *Eclipse*, 1885.

THE first meeting of the new session of the Royal Geographical Society takes place on November 12, when a paper on northeastern Rhodesia by Mr. L. A. Wallace will be read. According to the London *Times* this will be followed on November 19 by a paper on the Seychelles Islands by Mr. Stanley Gardiner, who spent some time in the islands during his

cruise in the Indian Ocean last year. On December 10 Major H. Beacom, the American military attaché, will give an account of the changes that have been effected by irrigation in the United States. At a meeting during the course of the session, probably in the spring, an authoritative account will be given of the results of the Duke of the Abruzzi's expedition to the Ruwenzori Mountains. Among other papers that are expected during the session will be one by Dr. Fridtjof Nansen, in which he will discuss the polar problems that still remain to be solved. This, it is hoped, will be the first of a series of papers on the unknown and little-known parts of the world, the object being to take stock of what we now know of the geography of the globe, with a view to showing what remains to be done before our knowledge is complete. Lieutenant Boyd Alexander, who is expected shortly to arrive in England, will give an account of his expedition through Central Africa from the West Coast to the Nile. Colonel A. W. S. Wingate will give an account of the results which have been achieved during his nine years' directorship of the survey work in Northern China and Mongolia. Major C. D. Bruce will give a paper on his journeys through Central Asia to Northern China; and the following are among other papers that are expected during the session: 'The North Magnetic Pole and the Northwest Passage,' by Captain Amundsen; 'Aboriginal India,' by Colonel Sir T. H. Holdich; 'A Journey from Yunnan to Assam,' by Mr. E. C. Young; 'The Story of London Maps,' by Mr. Laurence Gomme; 'The Evolution of the Map of Africa,' by Mr. Edward Heawood; 'Inland Waterways,' by Mr. G. G. Chisholm; 'The Taupo Volcanic Region, New Zealand,' by Mr. J. Mackintosh Bell, the director of the New Zealand survey. Other subjects will be brought before the research department of the society for discussion; and it is hoped that a decided step will be taken in the inquiry, which was instituted some time ago, into the changes which have taken place on the North Sea coast of England during the historical period.

The new laboratory of physical and electro-chemistry, which has been presented to Liverpool University by Mr. E. K. Muspratt, president of the council, was opened on October 13 by Sir William Ramsay, F.R.S. The London *Times* states that the new laboratory makes an addition of high importance and value to the university's equipment, and also confers upon Liverpool the distinction of being the only city in the United Kingdom to possess a special and completely-equipped laboratory for the study of physical and electro-chemistry. The cost of the laboratory, which provides accommodation for forty-three persons, is over £15,000. The laboratory will not be in readiness for the commencement of its work until some time in November, the formal opening being arranged for October 13 with the object of securing the attendance of a number of foreign scientists. In the absence of Lord Derby, chancellor of the university, Vice-Chancellor Dale presided over a large and distinguished gathering, amongst others present being Professors W. Ostwald (Leipzig), R. Abegg (Breslau), Ruhemann (Cambridge), H. Goldschmidt (Christiania), E. Cohen (Utrecht) and Lash Miller (Toronto). Sir William Ramsay, in opening the laboratory, remarked that the chief duty of a chair of physical chemistry was to teach men to think for themselves. He advised that the students of that fascinating subject should be induced by example, precept, sympathy, exhortation, and by all means whereby young human minds could be influenced to extend the bounds of their subject. Physical chemistry was important, not only from a scientific, but also from an industrial point of view, and the erection of that laboratory might be viewed as a monument to the services rendered by physical chemistry to manufacture in the past as well as a tribute to its donor's belief in future benefits which would accrue from its study. In the history of man there had never been an age like ours for scientific progress. As was the Elizabethan era for poetry and literature, so was the present for scientific achievement. Within twenty-five years they had seen a new chemistry develop—the chemistry

of the ion—and they were now eagerly and anxiously following the growth of the chemistry of the electron.

The British Medical Journal says: "M. Clemenceau, the new prime minister of France, has created a ministry of labor; this has involved the readjustment of certain public offices, for to the new minister of labor has been assigned not only labor and insurance and providence funds formerly under the control of the minister of commerce and mines formerly belonging to the department of the minister for public works, but also poor relief and public sanitation departments hitherto directed by the minister of the interior. M. Clemenceau has gained more fame as a politician and political writer than as a physician, but he was at one time in practise in Paris, so that he must be well acquainted with the needs of the public health service, and it is rather surprising to find him sactioning an arrangement which assigns to a minister of labor, who will have so many other interests committed to his care, the incongruous duty of presiding over the public health administration."

THE London *Times*, usually very correct in its scientific news, contains the following remarkable announcement: "Professor Josef Nowack, the Austrian scientific authority, arrived at Plymouth yesterday by the North German Lloyd steamship Barbarossa, bringing with him 26 cases of the rare plant *Abrus precatorius nobilis*, which is said to have extraordinary properties in the prediction of atmospheric and seismic disturbances. The total number of specimens which the professor has collected in Mexico and Cuba is 1,400, and they were sent to London, where they are to be exhibited. Professor Nowack intends to establish an institute in England for the prediction of weather conditions and the forecasting of storms, earthquakes, volcanic eruptions and accumulations of fire damp in mines. His system, he explained, is primarily based upon the discovery of the weather plant, 'also upon *data* obtained from studies of sun-spots, statistics of natural phenomena throughout the world, and upon general studies in physics, geology, chemistry and the physiology of plants.' The weather plant, he explained, had been found peculiarly sensitive to magnetic influences, and when changes occur in the electric and magnetic forces of the atmosphere, its twigs and leaves perform peculiar and abnormal movements, each movement having a definite significance. By its aid earthquakes and other influences can be predicted 26 days in advance. One thousand of the plants have been placed in the Botanical Gardens, New York, and those now brought to England are to remain here. There are to be bureaux in Bombay, Tokio and San Francisco, and one institution already exists in Vienna. Professor Nowack says that he can issue daily forecasts showing from two to seven days in advance the lists of rainy, foggy, or fine weather. One station, he says, will be sufficient for an area of 3,000 square miles, covering the whole of Europe, North Africa and the North Atlantic Ocean. Much interest is taken in the professor's researches in Austria, where he has the support of the emperor and the government."

CONSUL URBAIN J. LEDOUX reports from Prague that Austrian papers are discussing the introduction of the Kjellin process in the manufacuture of steel by the Poldihütte, at Kladno, Bohemia, in concert with the Oberschlesische Eisenindustrie-Gesellschaft, which process, says the Prague *Tageblatt*, may bring about a complete revolution in the Austrian steel industry. Continuing, the *Tageblatt* says: That such steps may be leading to vastly important results may easily be realized when it is considered that the Kjellin process yields an excellent steel, said to be fully equal to the best crucible steel, while the cost of production is considerably lower than with the mode of production so far in use. The Kjellin product, however, apart from its lower cost, is further praised for its ductility, density, homogeneousness, softness, the possibility of obtaining high degrees of carboniferous quality and, finally, for its excellent magnetic properties. If these surmises—as appears highly probable—should be proved by facts, all undertakings which have at their disposition the primary requisite for the adaptation

of the electric process, viz., cheap electric power by means of sufficiently strong water power, will secure a great advantage over other works. Chief Engineer V. Engelhardt, in his work on the Kjellin process, states that it can compete with the Siemens-Martin method, where the kilowatt hour can be put down at about a half cent.

UNIVERSITY AND EDUCATIONAL NEWS.

At the University of Wooster the addition to the library is nearing completion. The finished building will represent an expenditure of $71,000, all of which has been provided by Mr. Henry C. Frick. At the cost of $80,000, a dormitory is being built which will accommodate ninety young women.

The University of Nebraska plans to build an engineering hall (costing $100,000), a horticultural hall (costing $40,000) and a heating plant for the School of Agriculture ($40,000). Plans have been made to ask the legislature for an increase in the appropriation for the woman's building so as to make it $80,000.

Mr. John Charlton has given $50,000 to Queens University, Kingston, to endow a chair of moral philosophy.

Mr. Andrew Carnegie, lord rector of St. Andrews University, has given £10,000 to build a new university library; he has also given £12,500 to Dundee University College for a physical laboratory.

The University of Pennsylvania is about to begin a number of special courses, practically constituting a new department, by which school teachers, both men and women, will be able to obtain the regular college degree of bachelor of arts or bachelor of science.

At a meeting of the regents of the University of Nebraska, October 23, the grade of 'head professor' was established and the following appointments under this title were made for the subjects named: G. E. Barber (Latin); L. A. Sherman (English literature); C. E. Bessey (botany); J. T. Lees (Greek); H. W. Caldwell (American history); E. H. Barbour (geology); F. M. Fling (European history); E. W. Davis (mathematics); Lawrence Bruner (entomology); Laurence Fossler (German); H. B. Ward (zoology); G. W. A. Luckey (education); W. G. L. Taylor (political economy); C. R. Richards (mechanical engineering); O. V. P. Stout (civil engineering); E. A. Burnett (animal husbandry); A. T. Peters (animal pathology); Samuel Avery (chemistry); Roscoe Pound (law); G. E. Howard (sociology). It was further ordered that these 'head professors' should constitute the 'university senate.'

Dr. Andrew F. West, professor of Latin at Princeton University and dean of the graduate school, has declined the offer of the presidency of the Massachusetts Institute of Technology made to him by the executive committee of the corporation.

The following appointments have been made in the department of philosophy in the University of Michigan: Mr. Roy W. Sellars, A.B. (Mich.), sometime fellow of the University of Wisconsin, to be instructor in philosophy; Mr. John F. Shepard, B.S., Ph.D., to be instructor in psychology; Mr. Frank van Vliet and Mr. L. W. Elder to be George S. Morris memorial fellows in philosophy.

Mr. Samuel W. Collett, fellow in botany, State University of Iowa, has been appointed instructor, *ad interim*, in the State College of Washington.

Dr. G. H. F. Nuttall, M.D., F.R.S., fellow of Christ's College and reader in hygiene in the University of Cambridge, has been elected to the newly-created Quick professorship in biology. His duties are to devote himself to the study of the protozoa, especially such as cause disease. Dr. Nuttall was at one time associate in hygiene at the Johns Hopkins University.

Mr. W. L. H. Duckworth, M.D., Sc.D., fellow of Jesus, has been appointed demonstrator of anatomy in Cambridge University.

At Trinity College Mr. F. J. Dykes, M.A. (Cambridge), late lecturer in mechanics at the Royal Naval College, Portsmouth, has been elected fellow and lecturer.

Mr. J. W. McBain, M.A. (Toronto), has been appointed lecturer in chemistry in University College, Bristol.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SECTION B—PHYSICS.

AT the summer meeting of the American Association for the Advancement of Science, held in Ithaca, N. Y., from June 28 to July 3, 1906, Section B met in joint sessions with the American Physical Society. The section was, in an especial sense, the guest of the department of physics of Cornell University, for on this occasion there occurred the formal dedication of the new Rockefeller Hall of Physics. At the dedication exercises there were addresses by President Schurman, Professor E. L. Nichols, Dr. Elihu Thomson, Professor W. H. Welch and by Professor W. A. Anthony (read by Professor Merritt, in Professor Anthony's absence). After the addresses, the magnificent laboratory was opened for inspection.

On account of the interest in the new laboratory, no doubt, the attendance at the regular sessions was large, there being about seventy present. The president of the American Physical Society being absent, the vice-president of Section B, Professor W. C. Sabine, presided at all the sessions. A very interesting joint program of twenty-seven papers was presented. Abstracts and titles are given below. Besides the features already mentioned, several receptions and excursions, and the general hospitality of Cornell University added greatly to the enjoyment of the meetings. This summer meeting was very successful.

A New Type of Young's Modulus and Hooke's Law Apparatus: B. B. Brackett, Clarkson School of Technology.

This apparatus has a horizontal bed or base of wood, about 1.8 m. long, 20 cm. wide and 5 cm. thick. At one end is a clamp elevated 6 cm. to hold the wire tested, and at the other end is a rather large disk pulley over which the wire is drawn, while weights attached to the vertical portion of the wire beyond the pulley supply the desired tensions.

To compensate for the springing of the light and not very rigid base, an easily rolling platform is placed upon the base, between it and the wire. One end of this platform is held by a spring in firm contact with the clamp just at the point where it grips the wire, but the platform is entirely free from the wire at all other points.

A micrometer microscope is placed on the end of the platform next to the pulley to read the elongations of the wire. This arrangement keeps the microscope at the same distance from the fixed end of the wire, however much the plank base may be warped or shortened by the tensions placed on the wire.

The apparatus is of very simple construction, is easily used, quickly adjusted and gives results of the most satisfactory kind.

A Convenient Lecture Room Resistance for Electrical Experiments: B. B. Brackett, Clarkson School of Technology.

The resistance is to be used for controlling the current from a dynamo circuit. Usually a tap is made from the lighting mains.

Twelve incandescent lamps are arranged within a partially open box, 70 cm. long and 25 cm. square. Single pole, double throw switches are connected to the lamps so that all possible parallel, series and combination groupings are readily obtained.

While open enough for ventilation and to make the switches easily accessible, the containing box protects both lamps and switches from all the usual accidents to such apparatus, and enables one to use it in any place or position, on either end or on any side.

All the connecting wires are plainly visible and this, with the regular arrangement of the switches, shows at a glance what grouping of the lamps is being used. Hence there is little probability of making a mistake. Short circuits can not be made by any position of the switches.

Two Neglected Factors in the Determination of Musical Quality: W. C. Sabine, Harvard University.

The musical quality of a sound in an ordinary room or other confined space is very greatly affected by the character of the walls. Diagrams are presented showing the effects of various wall surfaces and substances. The other factor is the sensitiveness of the ear to sounds of different pitch and a diagram is presented showing the relative intensity for equal loudness under ordinary musical conditions.

Silver Perchlorate as the Electrolyte for the Silver Coulometer: Henry S. Carhart, H. H. Willard and W. D. Henderson, University of Michigan.

A New Alternating-current Galvanometer: L. A. Freudenberger, Lehigh University.

A Lecture Experiment in Electrolytic Thermo-Electromotive Force: Henry S. Carhart, University of Michigan.

Note on the Graphical Representation of Non-Sinusoidal Alternating Currents: Frederick Bedell, Cornell University.

Spark Potentials in Liquid Dielectrics: Robert F. Earhart, Ohio State University.

Measurements on the potential required

to cause a spark to pass between a ball and plate were made, with kerosene, olive oil, paraffin oil and a transformer oil as the intervening dielectrics.

Distances of separation vary from .003 to .118 mm. and were measured in terms of wave-lengths of sodium light.

A plane surface was attached to the movable carriage of an interferometer. This was brought in contact with a ball mounted on the interferometer base. These were separated and the fringes crossing the interferometer field noted. From this data distances of separation of the surfaces were computed.

P.D.'s were obtained from an A.C. transformer and were measured with a Weston voltmeter.

The data secured are compared with similar measurements made by the author when air was used as a dielectric.

Spark potential-distance curves for the various oils used give curves similar in form to those for air.

These experiments on the limited number of oils used indicate:

1. A higher potential gradient for small than for large distances.

2. That for small distances air is a better insulator than a liquid dielectric.

3. That the potential at which the bend in the potential-distance curve occurs is the same for air and the liquids operated upon.

The Dispersion of Silver Chloride: E. F. NICHOLS and W. S. DAY, Columbia University.

Properties of Electric Charges on Moving Conductors: E. F. NICHOLS, Columbia University.

The Separation of Electric Charges in a Metal by Centrifugal Acceleration: E. F. NICHOLS, Columbia University.

Comparative Observations on the Evolution of Gas from the Cathode with the Glow Current in Helium and Argon: CLARENCE A. SKINNER, University of Nebraska.

The Effect of Absorbed Hydrogen on the Photoelectric Current: W. F. HOLMAN, University of Nebraska.

Light from a spark arc between iron terminals in hydrogen was directed through a quartz optical system on to a zinc disk, serving as cathode—a disk of aluminum opposite serving as anode—the electrodes being in a highly evacuated chamber. Under these conditions the rate of leak of negative electricity from the zinc was represented by 32 scale divisions of the measuring instrument.

The zinc was then partially relieved of its supply of hydrogen by use as cathode with the glow discharge in hydrogen, after which it was again tested as before for its photoelectric current, which was found to be now represented by only about 22 scale divisions. This test was followed by using the zinc as anode with the glow discharge in hydrogen, the object of which process was to store up in it a new supply of hydrogen. A test of the photoelectric current as before showed that it had returned to its first value, giving, namely, a deflection of about 32 scale divisions.

The Production of Ozone by Becquerel Rays: HARRY S. HOWER, Case School of Applied Science.

The Production of Ozone by the Photoelectric Current in Oxygen: HARRY S. HOWER, Case School of Applied Science.

Fluorescence Absorption in Resorufin: FRANCES WICKE, Cornell University.

Further Experiments on the Phosphorescence of Sidot Blende: E. L. NICHOLS and ERNEST MERRITT, Cornell University.

Magnetograph Records of Earthquakes with Special Reference to the San Francisco Earthquake of April 18, 1906: L. A. Bauer, Magnetic Survey, Washington.

Rotation and Elliptic Polarization produced by Iron Films in a Magnetic Field: W. D. Harris, University of Nebraska.

Films were obtained on microscope cover glass by cathode deposit *in vacuo*. The rotation of the plane of polarization was measured by use of a Lippich half-shade Nicol prism, and the ellipticity of the light by means of a Brace half-shade elliptic polarizer and compensator. Films deposited in hydrogen exhibited a rotation rising gradually from zero in the violet to a maximum value in the red. The same films showed an ellipticity of the transmitted ray increasing from a zero value in the violet to a maximum at about 600 $\mu\mu$, then a gradually decreasing value toward the red end of the spectrum. With age the values for the longer wave-lengths dropped to a marked extent. A film of same density deposited in nitrogen produced a smaller rotation as well as smaller ellipticity, the latter possessing a maximum value at about 560 $\mu\mu$. A film deposited in oxygen gave no rotation for any wave-length, but a slight ellipticity, this being a maximum at about 540 $\mu\mu$ and dropping rapidly to zero in passing toward either end of the spectrum. All films showed marked polarity when suspended in a magnetic field.

The film deposited in hydrogen tested for variation in ellipticity with the strength of field showed this to be proportional to the field up to about 8,000 C.G.S. units, after which there was but a small increase as the field was intensified.

The reflected light exhibited in no case any observable ellipticity, although three per cent. of that observed in case of transmitted light would have been readily detected.

Cobalt and nickel films deposited in hydrogen showed a rotation similar to iron, but no ellipticity.

Coefficient of Linear Expansion at Low Temperatures: H. G. Dorsey, Cornell University.

New Diffraction Spirals: A. G. Webster, Clark University.

The Calibration of Capillary Tubes: Willard J. Fischer, Cornell University.

The Latent Heat of Recalescence in Iron and Steel: Frank H. Bailey, Clark University.

Thermal and Electrical Effects in Soft Iron between 100° and 218°: Edwin H. Hall, Harvard University.

This will give the results of a continuation of the study which my colleagues and I have already published, in the *Proceedings* of the American Academy for May, 1906. The general method followed has been the same as before and the results obtained are in general accord with those which we have before obtained at a lower temperature.

Note on Certain Aspects of Drude's Electronic Theory of Metallic Conduction: Edwin H. Hall, Harvard University.

I wish to raise the question whether the expansion of metals is to be accounted for by the expansive force of the imprisoned electrons and what effect these electrons should have on the specific heat of metals.

The Capacity and Resistance of Aluminum Anode Films: C. McC. Gordon, Central University of Kentucky.

Films were formed on aluminum anodes with a direct current of known voltage and their capacity measured in the Wheatstone bridge with a small alternating current.

As was reported in a previous paper, the

capacity was found to be practically independent of the electrolyte so long as water solutions are dealt with. Since, *cet. par.*, the capacity decreases proportionally to the thickness of the film, for the sulphuric-acid films to have a capacity as large as the films formed in other solutions seemed to be contradictory to the observation of others who had investigated the question of the thickness of the films; the sulphuric-acid films always having been found to be much thicker than those in other solutions.

Further experiments by the writer have confirmed the results as to the greater thickness of the sulphuric-acid film, as well as the fact that they do not have any smaller capacity than the others. With water-cooled tubular electrodes sulphuric-acid films more than 0.3 mm. thick were formed; but their minimum capacity values were slightly larger than those of other films whose maximum thickness could not have been more than 0.001 mm. Sodium sulphate gives films similar to those in sulphuric acid as to both thickness and capacity.

These results necessitate the conclusion that with the sulphates *the insulating film is not the whole film;* but that we have, superimposed on the insulating film, whose capacity is measurable, a conducting film many times thicker. For solutions other than the sulphates there is no evidence for any such dual-natured film.

The resistance of these films as measured by the Wheatstone bridge with small alternating current is much smaller than the apparent resistance as calculated from the residual direct current.

Bridge measurements were taken both while the direct current was still acting and after it was turned off, while the switching on or off of the direct current made no change in the capacity, the resistance of the films was only about one third as large with the current on as with it off.

Spark Potentials between a Point and Plane, for Small Distances: ROBERT F. EARHART, Ohio State University.

Measurements were made on the P.D. required to cause a spark to pass between a needle point and plane surface. The P.D.'s were secured from an A.C. transformer and were measured with a Weston voltmeter. No. 10 Sharp needles were used as the point electrode. A large number of needles were examined with a microscope and points approximating a pattern needle were chosen.

Distances separating the electrodes were measured with an interferometer.

Curves representing the relation between spark-potential and distance are similar to those showing the same relation between a spherical electrode and a plane.

For air, at atmospheric pressure the so-called 'minimum potential' was found to lie between 290 and 310 volts.

This value does not agree with results secured by other observers from static machines. The value given by Tamm is 2,150 volts when the point is negative and 3,300 for a positive point.

DAYTON C. MILLER,
Secretary of Section B.

THE SCIENTIFIC INVESTIGATION OF THE PSYCHICAL FACULTIES OR PROCESSES IN THE HIGHER ANIMALS.[1]

FOR a consistent investigator there is in the higher animals only one thing to be considered—namely, the response of the animal to external impressions. This response may be extremely complicated in comparison with the reaction of animals of a lower class. Strictly speaking, natural science is under an obligation to determine

[1] The Huxley lecture on recent advances in science and their bearing on medicine and surgery. Delivered by Professor Ivan P. Pavlov at Charing Cross Hospital on October 1, 1906. From the report in the *British Medical Journal.*

only the precise connection which exists between the given natural phenomenon and the responsive faculty of the living organism with respect to this phenomenon—or, in other words, to ascertain completely how the given living object maintains itself in constant relation with its environment. The question is simply whether this law is now applicable to the examination of the higher functions of the higher quadrupeds. I and my colleagues in the laboratory began this work some years ago, and we have recently devoted ourselves to it almost completely. All our experiments were made on dogs. The only response of the animals to external impressions was a physiologically unimportant process—namely, the excretion of saliva. The experimenter always used perfectly normal animals, the meaning of this expression being that the animals were not subjected to any abnormal influence during the experiments. By means of a systematic procedure easy of manipulation it was possible to obtain an exact observation of the work of the salivary glands at any desired time.

It is already well known that there is always a flow of saliva in the dog when something to eat is given to it or when anything is forcibly introduced into its mouth. In these circumstances the escaping saliva varies both in quality and quantity very closely in accordance with the nature of the substances thus brought into the dog's mouth. Here we have before us a well-known physiological process—namely, reflex action. It is the response of the animal to external influences, a response which is accomplished by the aid of the nervous system. The force exerted from without is transformed into a nervous impression, which is transmitted by a circuitous route from the peripheral extremity of the centripetal nerve through the centripetal nerve, the central nervous system, and the centrifugal nerve, ultimately arriving at the particular organ concerned and exciting its activity. This response is specific and permanent. Its specificity is a manifestation of a close and peculiar action of the external phenomena to physiological action, and is founded on the specific sensibility of the peripheral nerve-endings in the given nervous chain. These specific reflex actions are constant under normal vital conditions, or, to speak more properly, during the absence of abnormal vital conditions.

The responses of the salivary glands to external influences are, however, not exhausted by the above-mentioned ordinary reflex actions. We all know that the salivary glands begin to secrete, not only when the stimulus of appropriate substances is impressed on the interior surface of the mouth, but that they also often begin to secrete when other receptive surfaces, including the eye and the ear, are similarly stimulated. The actions last mentioned are, however, generally considered apart from physiology and receive the name of psychical stimuli. We will take another course, and will endeavor to restore to physiology what properly belongs to it. These exceptional manifestations unquestionably have much in common with ordinary reflex action. Every time that there is a flow of saliva attributable to this cause, the occurrence of some special stimulus among the external influences may be recognized. On very careful exercise of his attention, the observer perceives that the number of spontaneous flows of saliva forms a rapidly diminishing series, and it is in the highest degree probable that those extremely infrequent flows of saliva for which no particular cause is at first sight apparent are in reality the result of some stimulus invisible to the eye of the observer. From this it follows that the centripetal paths are always stimulated primarily and the centrifugal paths secondarily, of course, with the interposition of the central nervous system.

In the first place, they arise from all the bodily surfaces which are sensitive to stimulation, even from such regions as the eye and the ear, from which an ordinary reflex action affecting the salivary glands is never known to proceed.

It must be observed that ordinary salivary reflexes may originate not only from the cavity of the mouth, but also from the skin and the nasal cavity. In the second place, a conspicuous feature of these reflexes is that they are in the highest degree inconstant. All stimuli introduced into the mouth of the dog unfailingly give a positive result in reference to the secretion of saliva, but the same objects when presented to the eye, the ear, etc., may be sometimes efficient and sometimes not. In consequence of the last-mentioned fact, we have provisionally called the new reflexes 'conditioned reflexes,' and for the sake of distinction we have called the old ones 'unconditioned.' Every conditioned stimulus becomes totally ineffective on repetition, the explanation being that the reflex action ceases. The shorter the interval between the separate repetitions of the conditioned reflex the more quickly is this reflex obliterated. The obliteration of one conditioned reflex does not affect the operation of the others. Spontaneous restoration of the obliterated conditioned reflexes does not occur until after the lapse of one, two or more hours, but there is a way in which our reflex may be restored immediately. All that is necessary is to obtain a repetition of the unconditioned reflex—as, for instance, by pouring vinegar into the dog's mouth and then either showing it to him or letting him smell it. The action of the last-mentioned stimuli, which was previously quite obliterated, is now restored in its full extent. If for a somewhat long time—such as days or weeks continuously—a certain kind of food is shown to the animal without being given to him to eat, it loses its power of imparting a stimulus from a distance—that is, its power of acting on the eye, the nose, etc.

We may, therefore, say that the conditioned reflex is in some way dependent on the unconditioned reflex. At the same time we see also the mechanism which is necessary for the production of our conditioned reflex. When an object is placed in the mouth, some of its properties exercise an action on the simple reflex apparatus of the salivary glands, and for the production of our conditioned reflex that action must synchronize with the action of other properties of the same object when the last-mentioned action, after influencing other superficial parts of the body that are sensitive to such stimuli, arrives in other parts of the central nervous system. Just as the stimulant effects due to certain properties of an object placed in the mouth may be associated as regards time with a number of stimuli arising from other objects, so all these manifold stimuli may by frequent repetition be turned into conditioned stimuli for the salivary glands. It must be remembered that in feeding a dog or forcing something into its mouth each separate movement and each variation of a movement may by itself represent a conditioned stimulus. If that is the case, and if our hypothesis as to the origin of the conditioned reflex is correct, it follows that any natural phenomenon chosen at will may, if required, be converted into a conditioned stimulus. Any ocular stimulus, any desired sound, any odor that might be selected, and the stimulation of any portion of the skin, either by mechanical means or by the application of heat or cold, have in our hands never failed to stimulate the salivary glands, although they were all of them at one time supposed to be ineffective for such a purpose. This was accomplished by applying these stimuli simultaneously with the action of the salivary glands, this action having been evoked by

the giving of certain kinds of food, or by forcing certain substances into the dog's mouth. These artificial conditioned reflexes, the product of our training, showed exactly the same properties as the natural conditioned reflexes previously described. As regards their obliteration and restoration, they followed essentially the same laws as the natural conditioned reflexes.

Up to the present time the stimuli with which we had to do were comparatively few in number, but were constant in action. Now, however, in another more complicated portion of the nervous system we encounter a new phenomenon—namely, the conditioned reflex. On the one hand, the nervous apparatus is responsive in the highest degree—that is, it is susceptible to the most varied external stimuli, but, on the other hand, these stimuli are not constant in their operation and are not uniformly associated with a definite physiological effect. The introduction of the idea of conditioned reflexes into physiology seems to me to be justified because it corresponds to the facts that have been adduced, since it represents a direct inference from them. It is in agreement with the general mechanical hypotheses of natural science. It is completely covered by the ideas of paths and inhibition, ideas which have been sufficiently worked up in the physiological material of the present day. Finally, in these conditioned stimuli, looked at from the point of view of general biology, there is nothing but a very complete mechanism of accommodation or, which amounts to the same thing, a very delicate apparatus for maintaining the natural equilibrium. There are reasons for considering the process of the conditioned reflex to be an elementary process—namely, a process which really consists in the coincidence of any one of the innumerable vague external stimuli with a stimulated condition of any point in a certain portion of the central nervous system. In this way for the time being a path is made by which the stimulus may reach the given point.

Although there are differences in the time required for the establishing of the conditioned reflexes, some proportionality may be perceived. From our experiments it is very evident that the intensity of the stimulation is of essential importance. In contradistinction to this we must state with regard to acoustic impressions that very powerful stimuli, such as the violent ringing of a bell, were not, in comparison with weaker stimuli, quick to produce conditioned increase of function in the salivary glands. It must be supposed that powerful acoustic stimuli produce in the body some other important reaction which hinders the development of the salivary reaction.

What is it that the nervous system of the dog recognizes as individual phenomena of external origin? or, in other words, what are the elements of a stimulus? If the application of cold to a definite area of the skin acts as a conditioned stimulus of the salivary glands, the application of cold to another portion of the skin causes secretion of saliva on the very first occasion. This shows that the stimulus of cold generalizes itself over a considerable portion of the skin, or perhaps even over the whole of it.

Stimulation by musical sounds or by noise in general is remarkably convenient for determining the discriminating or analytical faculty of the nervous system of the dog. In this respect the precision of our reaction goes a great way. If a certain note of an instrument is employed as a conditioned stimulus, it often happens that not only all the notes adjoining it, but even those differing from it by a quarter of a tone, fail to produce any effect. Musical *timbre* is recognized with similar or even much greater precision.

We have hitherto spoken of the analytical

faculty of the nervous system as it presents itself to us in, so to say, the finished condition. We have now accumulated material which contains evidence of a continuous and great increase of this faculty if the experimenter perseveres in subdividing and varying the conditioned stimulus, and thereby makes it coincide with the unconditioned stimulus. Here, again, is a new field of enormous extent. In this material relative to the conditioned stimuli there are not a few cases in which an evident connection between the effect and the intensity of a stimulus can be seen. As soon as a temperature of 50° C. had begun to induce a flow of saliva it was found that even a temperature of 30° C. had a similar effect but in a much less degree. Trial was then made of combinations consisting of stimuli of the same kind and also of stimuli of different kinds. The simplest example is a combination of different musical notes, such as a harmonic chord, which consists of three notes. When this is employed as a conditioned stimulus each two notes together and each separate note of the chord produce an effect, but the notes played two and two together accomplish less than the whole, and the notes played separately accomplish less than those played in pairs. The case becomes more complicated when we employ as a conditioned stimulus a combination of stimuli of different kinds, that is, of stimuli acting upon different kinds of susceptible surfaces. Only a few of such combinations have been provisionally experimented with. In these cases for the most part one of the stimuli was a conditioned stimulus. In a combination in which rubbing and cold were employed the former was preponderant as a conditioned stimulus while the application of cold taken by itself produces a hardly perceptible effect. But if an attempt is made to convert the weaker stimulus separately into a conditioned stimulus it soon becomes an energetic conditioned stimulus. If we now apply the two stimuli together we have before us an evident case of them acting in combination. The following problem had for its object to explain what happens to an active-conditioned stimulus when a new stimulus is added to it. In the cases that were examined, the action of the preexisting conditioned stimulus was hindered when a new stimulus of a like kind was added to it. A new odor of a like kind hindered the operation of another odor which was already acting as a conditioned stimulus; a new musical note similarly hindered the operation of the note previously employed which was a conditioned stimulus. After a conditioned stimulus had been applied, together with another one which inhibited its action, the action of the first one alone was greatly weakened and sometimes even stopped altogether. This is either an after-effect of the inhibiting stimulus which was added or it is the obliteration of the conditioned reflex, because in the experiment of the added stimulus the conditioned reflex is not strengthened by the unconditioned reflex. The inhibition of the conditioned reflex is also observed in the converse case. When you have a combination of stimuli acting as a conditioned stimulus—in which, as has been already stated, one of the stimuli by itself produces almost no effect—frequent repetition of the powerful stimulus by itself without the other one leads to a powerful inhibition of its action, even to the extent of its action being almost destroyed. The relative magnitudes of all these manifestations of stimulation and inhibition have a very close connection with their dependence on the conditions under which they originate.

Experiments have been made in the production of conditioned reflexes by traces or latent remnants both of a conditioned and of an unconditioned stimulus. The method was that a conditioned

stimulus was either allowed to act for one minute immediately in advance of an unconditioned stimulus or it was even applied two minutes earlier. Conversely, also, the conditioned stimulus was not brought into action until the unconditioned reflex was at an end. In all these cases the conditioned reflex developed itself; but in the cases in which the conditioned stimulus was applied three minutes before the unconditioned one, and was separated from the latter by an interval of two minutes, we obtained a condition which was quite unexpected and extremely peculiar, but was always repeated. When scratching was applied to a particular spot—for instance, as a conditioned stimulus—after it began to produce an effect it was found that scratching of any other place also produced an effect, just as in the case of cold or heat applied to the skin, new musical sounds, optical stimuli and odors. The unusually copious secretion of saliva, and the extremely expressive movements of the animal attracted our attention. It may appear that this manifestation is of a different kind from those with which we have hitherto been occupied. The fact was that in the earlier experiments at least one coincidence of the conditioned stimulus with the unconditioned one was necessary, but on the present occasion manifestations which had never occurred simultaneously with an unconditioned reflex were acting as conditioned stimuli. Here an unquestionable point of difference naturally comes to light, but at the same time there is also to be seen another essential property of these manifestations which they have in common with the former ones—that is, the existence of a very sensitive point in the central nervous system, and in consequence of its position this point becomes the destination of all the important stimuli coming from the external world to make impressions on the receptive cells of the higher regions of the brain.

Three characteristic features of this subject make a deep impression upon him who works at it. In the first place, these manifestations present great facilities for exact investigation. I am here referring to the ease with which they may be repeated, to their character of uniformity under similar conditions of environment, and to the fact that they are capable of further subdivision experimentally. In the second place, it is inevitable that opinions formed on this subject must be objective only. In the third place, the subject involves an unusual abundance of questions. To what departments of physiology does it correspond? It corresponds partly to what was in former days the physiology of the organs of special sense and partly to the physiology of the central nervous system.

Up to the present time the physiology of the eye, the ear and other superficial organs which are of importance as recipients of impressions has been regarded almost exclusively in its subjective aspect; this presented some advantages, but at the same time, of course, limited the range of inquiry. In the investigation of the conditioned stimuli in the higher animals, this limitation is got rid of and a number of important questions in this field of research can be at once examined with the aid of all the immense resources which experiments on animals place in the hand of the physiologist. The investigation of the conditioned reflexes is of very great importance for the physiology of the higher parts of the central nervous system. Hitherto this department of physiology has throughout most of its extent availed itself of ideas not its own, ideas borrowed from psychology, but now there is a possibility of its being liberated from such evil influences. The conditioned reflexes lead us to the consideration of the position of animals in nature; this is a sub-

ject of immense extent and one that must be treated objectively.

Broadly regarded, physiology and medicine are inseparable. Since the medical man's object is to remedy the various ills to which the human body is liable, every fresh discovery in physiology will sooner or later be serviceable to him in the preservation and repair of that wonderful structure. It is an extreme satisfaction to me that in honoring the memory of a great physiologist and man of science I am able to make use of ideas and facts which from a unique standpoint affording every prospect of success throw light upon the highest and most complicated portion of the animal mechanism.

SCIENTIFIC BOOKS.

Lehrbuch der Anorganischen Chemie. Von Professor Dr. H. ERDMANN, Direktor des anorganisch-chemischen Instituts der königlichen technischen Hochschule zu Berlin. Vierte Auflage (neuntes bis zwölftes Tausend) mit 303 Abbildungen, 95 Tabellen, einer Rechentafel, und sieben färbigen Tafeln. Braunschweig, F. Vieweg und Sohn. 1906. Pp. 796. In Leinwand gebunden M. 17.

A long review of the second edition of this book appeared in SCIENCE in 1901.[1] The present edition has been thoroughly revised, and contains valuable additions to text, to illustrations and to tables.

The weaknesses and the strong points of the book remain practically the same, as both are inherent in the author's scheme. Erdmann believes that a text-book of inorganic chemistry should describe the occurrence, properties, reactions, manufacture and uses of all inorganic elements and compounds, with liberal illustration of instructive experiments, of apparatus and of technical processes. No other one-volume text-book is so complete, so well illustrated and so thoroughly up to date in these respects.

Erdmann does not believe in the introduction of physical chemical theory in the descriptive text, but makes a brief résumé of general chemistry in the 87 pages of the introductory chapter. There are those who will sympathize with Erdmann in this arrangement, others who may be reminded of the eccentric American author who left his book unpunctuated and put several pages of commas, periods, etc., at the end of the book for use as the reader might please. Certainly many phenomena in the field of inorganic chemistry find the clearest explanation by the application of the laws of physical chemistry, and remain obscure if such explanation is not given.

This objection, however, does not lessen the practical value of Erdmann's book, because there is no text-book of inorganic chemistry written from a physical chemical point of view which is comparable with Erdmann even in general descriptive data, still less in technical information. It is, therefore, to be expected that this fourth edition will meet the same cordial reception and large sales as its predecessors. E. R.

Vermehrung und Sexualität bei den Pflanzen. Von E. KÜSTER. Leipzig, B. G. Teubner. 1906. Pp. vi + 120. 38 figures.

In America one is accustomed to look with suspicion upon all books in which an attempt is made to popularize science. All too often this suspicion is justified, for who has not met with books in which scientific accuracy has been sacrificed to the sensationalism demanded by a certain class of the public or where the science is so diluted by allegory or fable as to be unrecognizable. The book before us is, however, of an entirely different type. It is one of a series of popular scientific works ('Aus Natur und Geisteswelt') in which each book is written by a specialist who knows his subject.

The subject of reproduction and sexuality in plants is a difficult one to handle so as to be comprehended by persons who have studied but little or no botany and it is in this connection that the chief criticism can be made, to the effect that it is to be feared that parts of the book will be found too technical to be

[1] SCIENCE, Vol. XIII., pp. 268–70.

understood by such persons, at least with readiness.

Eighteen pages are devoted to vegetative reproduction with a discussion of cuttings, runners, bulbs, tubers, grafting, etc., in the higher plants, and of conidia, swarm-spores and fission in the fungi and algæ. Eighty-seven pages treat of sexual reproduction. The author traces the history of the knowledge of sexuality in plants from the Greek philosophers down to its demonstration by Camerarius, confirmation by Kohlreuter, discovery of the pollen-tube by Amici, observation of sexuality in cryptogams by Hofmeister, Thuret and Pringsheim, and the more recent investigations showing the part played by the nuclei, chromosomes, synapsis, etc., thus bringing the subject down to this year. After this historical and general discussion the different groups of plants are taken up, showing the increasing complexity of the sexual process from the union of two equal cells up to the complicated processes in the higher fungi and algæ, the alternation of generation and development of heterospory in the Archegoniatæ and the double fertilization in the Angiosperms. Under the caption General Questions are taken up sexual affinity, hybrids, polyspermy, parthenogenesis, parthenocarpy, apogamy, apospory, merogony and determination of sex. The final considerations take up the theory of fertilization and the theory of sex, the various views being presented in an unbiased manner as well as the objections to them.

Although professedly designed for those who are not specialists this book should prove valuable for both students and teachers. The references to literature, both old and very recent, although with no pretence to completeness, yet give the most important contributions bearing on the subject. The figures are, for the most part, very good.

Ernst A. Bessey.

SOCIETIES AND ACADEMIES.

THE AMERICAN PHILOSOPHICAL SOCIETY.

A stated meeting was held on Friday evening, November 2, 1906, at 8 o'clock. The following papers were read:

Dr. Alfred C. Haddon, F.R.S., University Lecturer in Ethnology, Cambridge, Eng.: 'The Decorative Art of British New Guinea.' (Illustrated.)

Dr. John W. Harshberger: 'A Grass-killing Slime Mould.'

DISCUSSION AND CORRESPONDENCE.

SOME POINTS IN TEACHING CRYSTALLOGRAPHY.

The writer wishes to call attention to and invite discussion of the following points in the teaching of crystallography as a part of the work in elementary mineralogy.

The best classification even for beginning students is that of the thirty-two crystal classes, based upon symmetry. All ideas of hemihedrism should be dropped as there is no structural connection between the whole and partial forms. The name of the class is the name of the general form. Groth's set of names is the best, but his names for the isometric classes may be replaced by the terms, tetartoidal, gyroidal, diploidal, hextetrahedral and hexoctahedral for classes twenty-eight to thirty-two.

A division of crystals into seven systems is preferable to that of six. Crystals with an axis of three-fold symmetry naturally form one system and those with an axis of six-fold symmetry another system. And this is true whether the three axes of Miller or the four axes of Bravais are used. The writer prefers to treat the orthorhombic system, one of moderate symmetry, first.

It is believed that von Fedorow's method of naming forms (adopted by Groth in his 'Physikalische Kristallographie') is the only logical one. The name of a form depends upon its shape and is independent of how it cuts the axes of reference. A pinacoid consists of two parallel faces whether its symbol is 100, *h0l*, *hkl* or what not. A pyramid is three or more like faces meeting in a point and a bipyramid is two such solids placed base to base. Instead of using a name for the particular form, *e. g.*, pinacoid of the first kind, as von Fedorow does, we may simply give the name of the form together with the symbol, *e. g.*, pinacoid (100).

There is weighty argument in using the Miller symbols even with beginners in crystallography. In elementary work only type symbols are used and for these the Miller system is as easy as any. One only has to replace one index of the symbol *hkl* by a zero when a face is parallel to an axis. When it comes to a question of actual symbols the Miller indices of course take precedence over the Weiss. If one learns Miller from the start there is never the necessity of translating back and forth from Weiss, which is a waste of energy. And lastly the Miller is the only universal system.

The fact that the axial ratios are irrational and that the indices are rational is a thing that always gives many students trouble. Thus most students can not see why the symbol 111 does not represent a face that cuts the three axes *a*, *b* and *c* at equal lengths. The writer has used a homely illustration that usually makes it clearer at least. Take two cities, laid out in different ways. A pedestrian on inquiring about a certain building in either place might be told: Go two blocks north, three blocks east. Yet the actual distance he had to walk in the two cities would be different, for the lengths of the blocks are different. These distances are on record and correspond to the axial ratios. Yet the pedestrian is not concerned directly with them. The two blocks and three blocks correspond to the indices.

In order to really understand some of the essential points of crystallography the student must devote some time to crystal measurement, calculation and drawing. And without something of the sort, the time given to crystallography may almost be a waste of time unless it is taken up at some future time. To accomplish this in the limited time available in a general course in mineralogy is difficult. The writer has had partial success with the following method. Selected crystals or wooden models preferably orthorhombic with 110, *hk*0, 011 and one or more of 100, 010 or 001 are chosen.

(1) Free-hand sketch of the crystal.

(2) Number faces and indicate zones.

(3) Measurement of interfacial angles with the contact goniometer.

(4) Stereographic projection on sheets devised by Penfield.

(5) Graphic determination of *a* and *c* from 110 and 011.

(6) Graphic determination of indices *hk*0.

(7) Orthographic projection (plan and elevation) from stereographic.

Taken up in this manner the work is not at all difficult for the drawing of zone circles is not necessary in the stereographic projection and the tedious clinographic projection is replaced by the orthographic. Yet the student appreciates something of the meaning of axial ratios and indices and is ready, if need be, to take up more advanced work.

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SPECIAL ARTICLES.

IS THERE DETERMINATE VARIATION?

HOWEVER willingly we incorporate in our general conception and knowledge of variation the special conception of mutations (in the de Vriesian sense) and however implicitly we accept de Vries's primrose species by mutation, we must none the less hold clearly in mind that the kind of variation still most familiar to us all is that kind variously called individual, fluctuating, continuous or Darwinian variation, and we must not for a moment, because some species may have been shown to have arisen in some other way, deem ourselves absolved from the responsibility of further testing the Darwinian assumption of species-forming by the natural selection of individuals possessing advantageous slight variations.

If new species arise by virtue of a cumulation or progressive increase of small fluctuating variations in continuous series, they can apparently only do so through (*a*) natural selection, or (*b*) determinate or orthogenetic variation. The principal argument for a belief in determinate variation so far advanced seems to be that natural selection is unable to make use of fluctuating variation because (1) this variation is too small and useless to be a handle for life and death selectivity, and be-

cause (2) of the swamping or extinguishing of favorable variations by their intermating with unfavorable or neutral conditions.

Thus there is necessary some influence tending to cumulate variation independent of, or antecedent to, selection. This influence or causal factor in species-forming on a basis of continuous variation must, therefore, be something whose result is determinate or orthogenetic variation. What can produce such progressive variation doesn't for the moment seem very obvious. But a prior consideration for observation and experiment (pedigreed breeding) may well be that of the determination of whether we can actually distinguish the occurrence of the determinate variation. If we can't discover its existence we need not trouble our fevered wits with questions of how it might be produced.

I wish, therefore, to present some facts[1] concerning a little green and black beetle that infests our Californian flower gardens—one *Diabrotica soror* or 'California flower beetle' by name—that seem to me to have intimate relation to the problem just stated.

This beetle has its black and green colors arranged on its back (dorsal surfaces of the wing-covers) in the form of twelve distinct black blotches or spots on a green ground, six spots in three transverse pairs (or two longitudinal rows) on each wing-cover. At least the original description of this species gives this patterning, and systematic accounts and revisions of the genus have always ascribed to the species *soror* twelve separate black blotches on a green (or yellow-green) ground. In Horn's revision of the genus in 1893 (*Trans. Amer. Ent. Soc.*, V. 20, p. 89 ff.) the fact of a tendency of the black spots to coalesce is fleetingly referred to. But undoubtedly the twelve-free-spots type is the pattern which is accepted as the typical and usual one.

In its larval stage this beetle lives as a slender white grub underground, feeding on the roots of alfalfa, chrysanthemum and various other plants. It pupates in a small subterranean cell near the surface and the adult beetle, on issuance from the pupal cuticle, makes its way aboveground and feeds on the buds and opened flowers of roses, chrysanthemums and almost any other of California's favorite blossoms. The color pattern of the adult is, of course (as the insect is one of 'complete metamorphosis') definitive and fixed as to both pattern and color at the time of the first appearance of the adult aboveground.

By the aid of several industrious assistants I have been able to collect from the same locality in the same months each year a thousand or more specimens of *Diabrotica soror* in each of five separate years included in the last decade. In addition, we have made other collections from other localities in California of series varying from a few score to a thousand individuals. With the help of these same indefatigable[2] helpers all of these thousands of beetles have been closely scrutinized and honestly described with regard to the actual condition of their elytral pattern. The results of this work are graphically represented in the accompanying 'frequency polygons' and statistical tabulations.

From this scrutiny and compilation it is apparent, (1) that in this patterning variations of the strictly fluctuating or continuous sort exist, as was to be expected; (2) that this variation is strongly marked and hence readily tabulatable, which is fortunate for our study; (3) that this variation does not follow Quetelet's law of error, in which characteristic it departs from the usual condition of fluctuating variation, but is not unique; (4) that this variation plainly sets strongly in a certain specific direction, that is, tends strongly toward the production of one particular new type of pattern rather than toward dissipating itself by futile equal attempts in various and thus mutually extinguishing directions; and (5) that this tendency is on the steady increase in our own times, under our very eyes.

The pattern variation is shown (by selecting certain principal types appreciably distinct)

[1] See Kellogg and Bell, 'Studies of Variation in Insects,' *Proc. Wash. Acad. Sci.*, Vol. 6, pp. 203–332, 1904, for a detailed account of the variation in *Diabrotica soror*.

[2] Instructor R. G. Bell and students R. Patterson and B. E. Wiltz.

in Fig. 1, where *A* represents the condition accepted by the systematists as typical of the species (both right and left elytra are shown); *B* shows the two spots of the middle transverse pair of the left wing-cover fused; *C*, the corresponding two spots of the right wing-cover fused; *D*, the two spots of the posterior transverse pair of the left wing-cover fused; *E*, the corresponding spots of the right wing-cover fused; *F*, the longitudinal fusing of the spots on the left wing-cover, and *G*, the corresponding condition for the right wing cover.

These different patterns are closely connected by intergrading conditions; that is, there may be (theoretically) and are (actually) all degrees of fusion of the two spots in

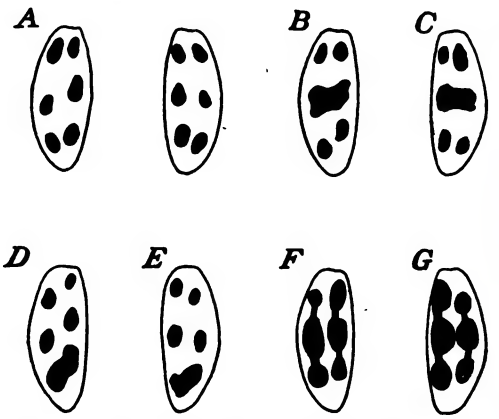

FIG. 1. Diagrammatic representation of the varying elytral color pattern of the California flower beetle, *Diabrotica soror*.

these various pairs that show fusion at all, from the slightest running together to the complete type shown by the diagrams of Fig. 1. But for the sake of aggregating individuals into describable groups any fusion is called fusion, and the existence of even the slightest space or line of green between two spots is recognized as 'no fusion' or 'free spots.' As a matter of fact, in the great majority (about five sixths) of cases of fusion the spots are well joined.

In the following tabulations and graphic representations (by frequency polygons) of the condition of the varying color pattern in the species (on the Stanford University campus) in different years, series of approximately 1,000 are used. That a series of 1,000 individuals collected from one locality at one time fairly represents, in the variation revealed by its members, the actual variation conditions of the species in this locality, as regards both kinds of variation and frequency of these kinds, is proved by repeated tests made by examining and tabulating successive

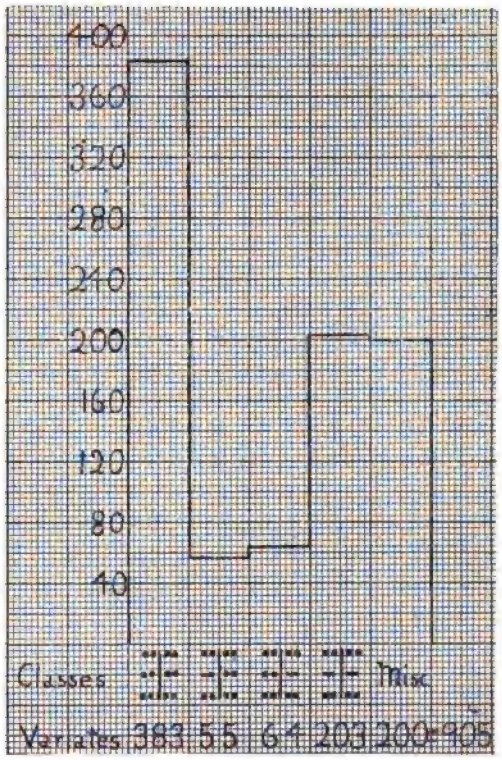

FIG. 2. Frequency polygon of the variation in elytral pattern of 905 specimens of the California flower beetle, *Diabrotica soror*, collected on the Stanford University campus, 1895.

thousands and finding a practical identity in these separate series. Indeed, series of 500 gave practically always approximately the same curve as those of 1,000. But the larger number is the safer.

Attending now to the actual variability shown by the elytral color-pattern of *Diabrotica soror* in the various series examined (in the years 1895, 1901, 1902, 1904 and 1905), we find the species in 1895 showing (Fig. 2

and caption) a marked preponderance of the twelve-spots-free condition (*A* in Fig. 1) over any other pattern type, but a much stronger proportion of a certain one of the variant types than of any other form of variant. This second modal type is the one in which the members of the middle pairs of spots are fused on both wing-covers (*B* and *C* of Fig. 1). The other important variants are middle spots fused on either right *or* left wing-cover, posterior spots fused on either or both right and left wing-covers, and various longitudinal fusings. Fig. 2 and its caption give the exact data of the arrangement of this variability. (The transverse fusing of the posterior spots and all the longitudinal fusings are grouped together as 'misc.')

But note now Figs. 3, 4, 5, 6 and 7, with their captions, giving the condition of this color-pattern variation in the years 1901, 1902, 1904 and 1905, respectively. In all these cases the variant $B + C$ or middle-spots-fused type is the predominating form. The following table shows the relative frequencies of the modal-pattern types in these successive years.

	All Spots Free.	Middle Spots Fused.
1895	42.35	22.40
1901	34.05	43.70
1902	34.05	42.80
1904	20.90	65.40
1905	35.20	46.50
1905[2]	26.87	53.92

If series of 1,000 really reveal the variation conditions of the color pattern in the species in these different years (and our check lots show that they do) it is apparent from these statistics that *Diabrotica soror,* in this particular locality has, in ten years, changed from a form in which one pattern type was the mode to one in which another is the mode. And this change has been gradual and cumulative; not made by a mutation or by discontinuous variation, *i. e.,* discontinuous evolution. The two modes or predominant types of pattern are connected to-day as they were ten years ago by all degrees of gradations; the variation, that is, is typically continuous or 'Darwinian' in type. Excluding then the mutation or discontinuous variation explanation of this species change there remain three possible explanations of the change (on the basis of current theories of species-modification); these are: (1) the change is simply ontogenetic, determined for each generation during its development by extrinsic influences; (2) the change is the result of natural selection; and (3) the change is due to determinate variation.

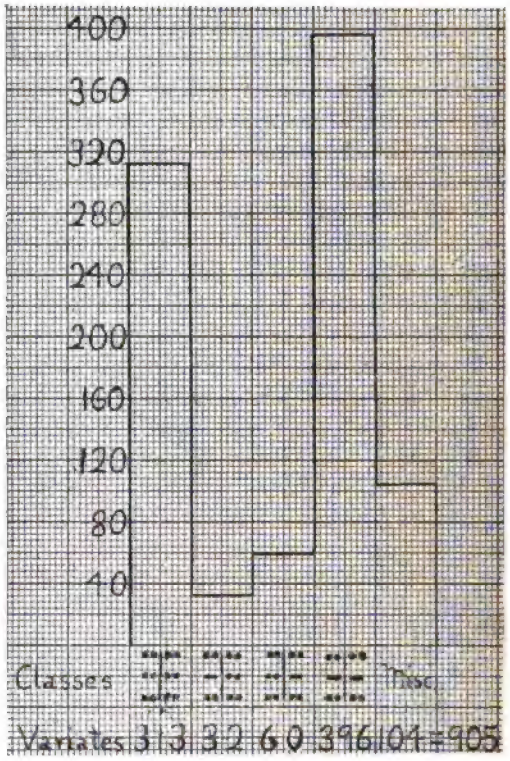

FIG. 3. Frequency polygon of the variation in elytral pattern of 905 specimens of the California flower beetle, *Diabrotica soror,* collected on the Stanford University campus, October, 1901.

The first explanation involves the assumption that the pattern is not inherited as such, but is acquired during the ontogeny of each individual as a result of environmental influence; and it further has to assume a present total environmental influence in this particular locality different from that in 1895 in the

[2] The second 1905 series was collected at a distance of several miles from the locality on the campus from which the other lots were taken.

degree and to the effect that it tends to cause an irregular transverse blotch (plainly formed by the fusion of two original separate blotches or spots) to appear in place of a transversal pair of blotches. As to the first assumption, the fact that the forming of the color pattern of the beetle requires but an hour or so, that it is carried on underground in the pupal cell, and that it is at no time exposed to above-

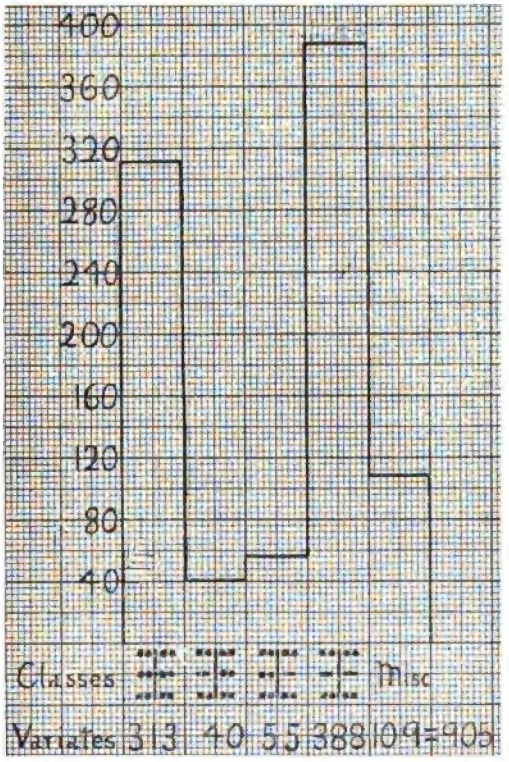

FIG. 4. Frequency polygon of the variation in elytral pattern of 905 specimens of the California flower beetle, *Diabrotica soror*, collected on the Stanford University campus, October, 1902.

ground conditions until it is in definitive unchangeable condition, and further that experiments with related species of Chrysomelid beetles (unfortunately not with this particular one) in the way of submitting the pupa and just-issued pattern-forming adult to various different conditions of light, temperature, humidity and color-surroundings, failed to produce any positive results whatever; all these facts strongly tend to invalidate the assumption of an ontogenetic determination of the color pattern. The second assumption, that of a change in environment in ten years sufficient to produce consistent ontogenetic

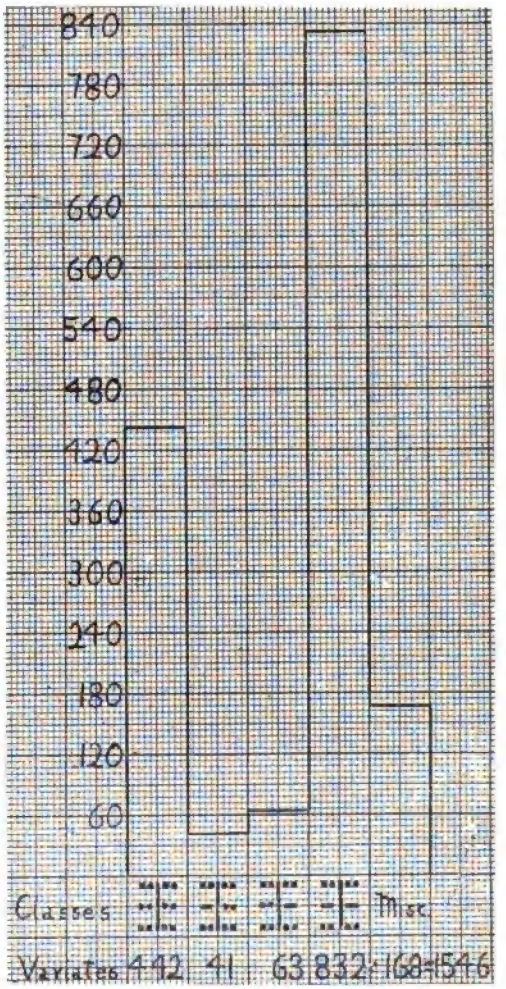

FIG. 5. Frequency polygon of the variation in elytral pattern of 1,546 specimens of the California flower beetle, *Diabrotica soror*, collected on the Stanford University campus, October, 1904.

changes in the color-pattern, certainly does violence to our knowledge, as far as it goes, of meteorological, cultural and other life-influencing conditions on our campus. No such changes are apparent.

The second explanation, that of natural

selection, based on a rigid intra-specific or individual selecting, tending to preserve the middle-spots-fused condition at the expense of the middle-spots-free condition, assumes an actual visual discrimination—let alone a presumable esthetic or preferential one—on the part of the lizards, birds and insect enemies of *Diabrotica;* that is, to be flippant, coming it much too strong for me. We really know

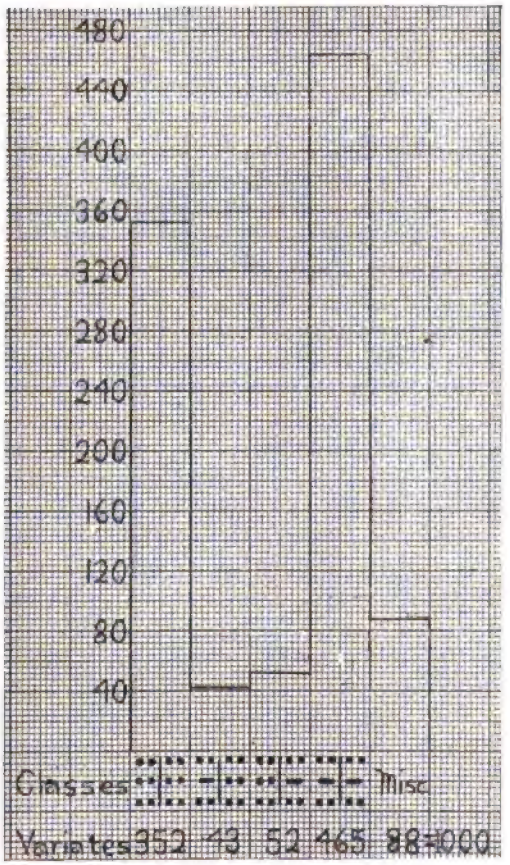

Fig. 6. Frequency polygon of the variation in elytral pattern of 1,000 specimens of the California flower beetle, *Diabrotica soror,* collected on the Stanford University campus, October, 1905.

something about the eyesight of lizards, birds and insects and it is fantastic to credit them with a capacity for distinguishing a character that in many cases requires on our part careful scrutiny with a lens to make out. When we straighten up after an hour's eye-straining work on this minute, though none the less real and from the species-student's point of view important, variation condition among our hosts of beetle specimens, we have in our minds one conviction about which there is moral certainty, and that is that no lizard,

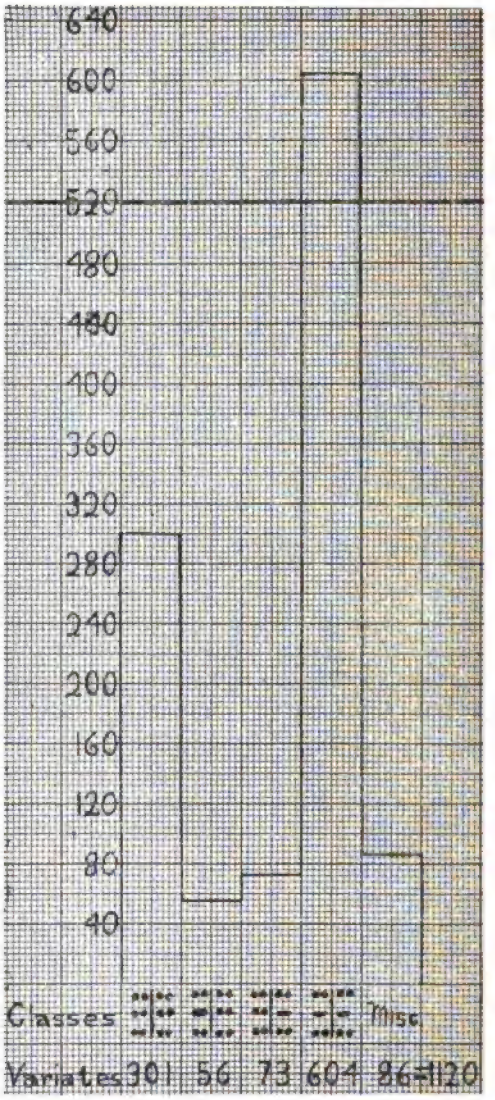

Fig. 7. Frequency polygon of the variation in elytral pattern of 1,120 specimens of the California flower beetle, *Diabrotica soror,* collected in the foothills of the Sierra Morena Mountains, about three miles from the Stanford University campus, October, 1905.

bird or insect is going to distinguish between beetle *A* and beetle *B* by the middle-spots-free or middle-spots-fused criterion. For one, I am done with meekly accepting the dictum of the selection champions who declare, in such cases as the present one, that we do not know what difference in general effect of harmony with leaf or flower or what not, and hence with the safety of the beetle, a very slight modification of pattern may produce; that we can not say of any difference, however minute, or apparently indifferent, that it is not the hair in the balance; and that when we understand *all* the conditions of the life of an organism, then, and only then, are we entitled to say of this or that character that it is not of life-and-death value. When we accept such a dictum we put aside all need of study, all spur to work, for '*all* the conditions' is a phrase to crush with. However, there are but few selectionists left who insist any longer on taking this point of view. Practically all Neo-Darwinians admit the existence of hosts of trifling, insignificant, indifferent species and variety characters. As for those who still hold to their crushing dictum—well, we can simply refuse to crush.

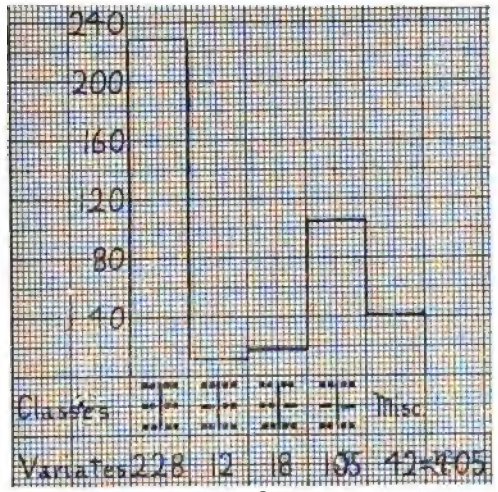

FIG. 8. Frequency polygon of the variation in elytral pattern of 405 specimens of the California flower beetle, *Diabrotica soror*, collected at Santa Rosa, California, about sixty miles north of the Stanford University campus, October, 1902.

In the particular instance before us, harmony of the color pattern of our beetle with its environment is out of the question. In fact, the glaring disharmony of the chrysomelid beetles with their habitual green leaf environment has been long notorious and has offered them a general card of admission to the group, probably not wholly fanciful, of 'aposematically' patterned animals, that is, creatures of malodor or distaste to their vertebrate enemies and conspicuously colored to warn these enemies of the malease which gastronomic attention to them will produce. So that the selective value of two-spots-fused or two-spots-free is that of helping make the pattern a distinct and readily perceived one. Now throughout the whole great family of Chrysomelid beetles the prevailing patterns are stripes, longitudinal or transverse, spots, and a clear ground color with neither spots nor stripes. In genus after genus in this family these three types of patterning are all represented by species of apparently equal abundance, vigor and general success in making life a burden to the horticulturalist and farmer. And these species with their different pattern types may, and often do, live side by side. Precisely in the genus *Diabrotica* is this interesting condition of things excellently exemplified. In the Mississippi Valley *Diabrotica longicornis*, with its unpatterned blue back, eats the sweet corn of the truck farmer, while the longitudinally black-striped *D. vittata* eats his cucumbers and melons, and the yellow *D. 12-punctata*, with its twelve separate black spots, attends to the rest of the truck. Here in California we are able to distinguish *D. soror* from *12-punctata* which ranges up to us from the middle west and great southwest only by the fact, quite sufficient for systematic coleopterologists, that the *under side* of thorax and abdomen and the bases of the legs (all parts well out of sight of preying lizard or bird) are strongly dusky instead of yellow. The exposed dorsal color pattern is the same in both. So that the differentiation of these two species was certainly never brought about by any selection of protective warning color-pattern variations.

We have also in our range a striped form, *trivittata,* hardly distinguishable from vittata.

Thus unstriped and unspotted or striped or spotted, all seem good patterns in the eyes of selection. To me, it is as clear as the

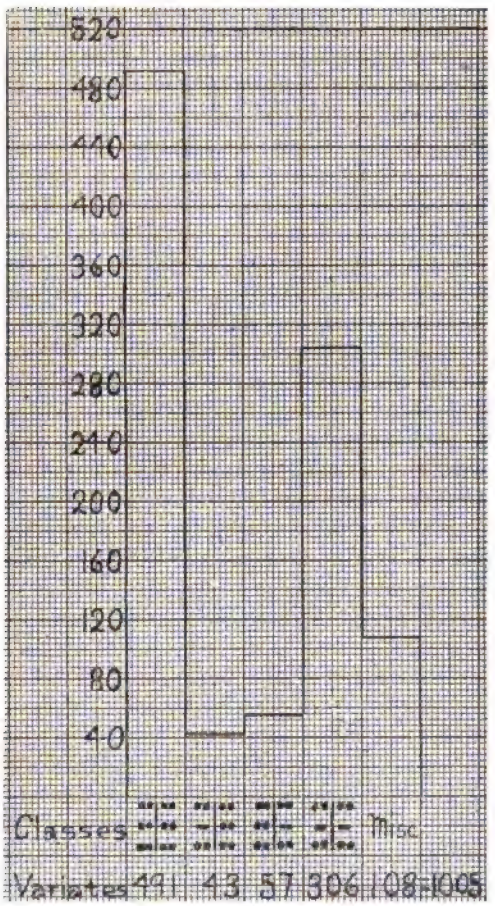

FIG. 9. Frequency polygon of the variation in elytral pattern of 1,005 specimens of the California flower beetle, *Diabrotica soror,* collected at San Jose, California, twenty miles south of the Stanford University campus, October and November, 1905.

significance of any fact in nature is clear, that the change in our locality in *Diabrotica soror* from a beetle species of typical twelve-spots-free pattern to one of eight-spots-free and two irregular transverse blotches in place of the middle four spots is not due to natural selection.

As to the third explanation, that of determinate variation, I have to say, simply, that there remains of our possible three explanations, one, which is that of determinate variation. But, we must note, if determinate variation is the explanation of this change in *Diabrotica soror* it is a determinate variation which is occurring only, apparently, in our particular locality. For in series of specimens of this bettle collected in other parts of California no such change seems to be going on, the old twelve-spots-free form being plainly the modal type. For example, in a series of 405 specimens collected in Santa Rosa, which is about sixty miles north of Stanford University, there are twice as many individuals with all spots free as of those with middle spots fused. (See Fig. 8 and caption.) And in a series of 1,005 individuals collected at San Jose, which is twenty miles south of Stanford University, nearly 49 per cent. are of the twelve-spots-free type and only 30.5 per cent. of the middle-spots-fused type.

Why the species should be changing on our university campus and not changing in the regions south and north of us is a mystery whose solution I do not even dare to guess at. This solution must have to do with the cause of the variation of the species on our campus. But if one asks what is this cause, what it is that is producing determinate variation in *Diabrotica,* or in any other species, I have, in this connection, only to refer to a statement in the beginning of this note, which is to the effect that prior to any attempt to explain how determinate variation might be produced it is advisable to attempt to determine if determinate variation really exists. Is there determinate variation?

VERNON L. KELLOGG.
STANFORD UNIVERSITY.

DISCOVERY OF AN EARLY TYPE OF MAN IN NEBRASKA.

IN a circular mound recently opened on a Loess hill north of Florence, near Omaha, Nebraska, various skeletal parts, and eight human skulls of a primitive type were exposed. The credit of the discovery belongs

to Mr. Robert F. Gilder, of Omaha, who described and figured the skulls in the *World-Herald,* October 21.

That there was intrusive burial in this mound is apparent from the fact that the skulls found below a layer of burned clay are of a much more primitive type than those found above it. Already five skulls have been taken from the lower level, and three from the upper, and others are in evidence and will be dug out later. Those of the upper layer probably belonged to Indians of a later period, and may be left out of account for the present. The skulls of the lower layer are low-browed and inferior, the superciliary ridges being thick and protruding, the distance through the temples narrow, and the frontal eminences being as feebly developed as in Neanderthal man. The low arch of the skull is not the result of head-binding, but is normal and characteristic as is evidenced by five crania, two of which are fairly complete. Unfortunately the occiput is fragmentary or wanting in the specimens now at hand.

The skulls are brachycephalic, and extremely narrow in transverse diameter through the temples, expanding rapidly at the parietals. Length of skull 182 mm.; minimum breadth 93 mm.; maximum breadth 160 mm.

In shape and size the mandible agrees well with that of modern man, although the following marked differences are to be noted; the bone, particularly in the region of the symphysis, is far heavier, the muscular scars more prominent, and the third molar in each case is ground to the very gum, while the second and third are ground in a diminishing ratio. The canines are weak and scarcely distinguishable from the incisors, and the space between the molars and the base of the coronoid is wide.

The limb bones indicate a stature of six feet, the femora being somewhat stronger, and the humeri being somewhat weaker than might be expected. The femora, which are massive, manifest an interior curvature more pronounced than ordinary, and in cross section they appear triangular through the great development of the linea aspera, all muscular scars and tuberosities are noticeably prominent, the scar for ligamentum teres being elliptical in outline, deep and nearly twice as long as broad.

The skulls of the Nebraska man seem to be inferior to those of the mound builder, but for the present at least will be viewed as early representatives of that tribe.

In corroboration are the flint implements or chips found associated with the skulls and bones, and the mode of burial. As work progresses a detailed illustrated report will be made.

E. H. BARBOUR,
H. B. WARD.

THE UNIVERSITY OF NEBRASKA,
October 27, 1906.

THE SECOND DECENNIAL OF THE BOTANICAL SEMINAR OF THE UNIVERSITY OF NEBRASKA.

THE botanical seminar of the University of Nebraska was organized, under the name of the 'Sem. Bot.,' as a secret society, by several advanced students in botany, on October 11, 1886. For some years it was an exclusive secret society. About 1891 it changed its policy and became a serious, scientific organization, aiming to promote research and, in particular, to organize the study of the vegetation of the state. Since that time it has admitted advanced students from time to time and has established two preliminary grades to which students are admitted after examination as a preparation for ultimate membership. It has conducted, since 1892, the botanical survey of Nebraska, has built up the survey herbarium and has published three parts of a 'Flora of Nebraska,' eight reports of the botanical survey, and the first volume of the 'Phytogeography of Nebraska.' At the same time that it has been engaged in this serious work, it has kept up the traditional secret organization, which now survives in certain traditional insignia, in the three grades of membership, and in certain traditional ceremonies.

On October 11 the seminar celebrated its second decennial. In the afternoon of that day all work in the botanical laboratories was suspended, and at three o'clock an open meeting was held which took the form of a sym-

posium on field methods, presided over by Dr. Clements.

In opening the symposium, Dr. Clements pointed out that the first decade of the organization coincided very closely with the period in which the botanical laboratory reached its greatest development. Consequently, in 1896, when the first decennial was celebrated, it was appropriate that the subject of the symposium should be 'Laboratory Methods.' During the second decade of its existence, it had fallen to the lot of the seminar not only to take part in, but also in large part to guide, the development of field work in ecology. For that reason it was especially fitting that the symposium on the occasion of the second decennial should deal with field methods.

Dr. Bessey spoke next upon 'The Place of Field Work in Botany.' He said in part:

The simplest kind of field work, and on many accounts the most productive and helpful, is that observation of plants and their environment which one makes when living much in the forests, the prairies, the swamps, the fields and the gardens. The man who lives 'in the open' and learns of plants and about plants while living with them, obtains a mass of most valuable botanical knowledge even though it may not be formulated in botanical language. Many an unlearned Thoreau knows much more about the habits of plants than the laboratory botanist who is a stranger to the wild plants in their native haunts. Then there is the more serious field—study in which with book or instrument the botanist tries to learn something accurately about plants as they grow out of doors. Here he learns something as to their classification in accordance with some general system and by means of his instruments, he learns something accurately as to the factors in the plant's environment that have controlled its growth and distribution. With such study, there usually comes the practise of collecting plants followed by the work of preserving, mounting and arranging in systematic order in the herbarium. This leads to closer and more accurate examination in the herbarium and the laboratory, and especially with the smaller kinds to critical microscopical study. Field work should underlie all botanical study. It can not be omitted without making the science one-sided. The student must do much of his work in the fields, forests and gardens if he is to make botany a science of living plants.

Dr. Barbour spoke upon 'Field Work in Geology and Physiography.'. He called attention to the relation of ecological and physiographical work in the field from the point of view of the geologist and the physiographer, showing, among other things, how the result of ecological investigation has enabled the physiographer to reach better results by enabling him to trace more accurately the physiographical conditions which he studies, by reference to the resulting effects upon vegetation.

Dr. Pound spoke of the field work done in the past by the seminar. He suggested that field work as conducted by the seminar in the past fell into three stages. In the first period, from 1886 to 1892, it took the form of collection only. During that time the object was simply to collect species and to make as many additions as possible to the reported flora of the state. In the second period, from 1892 to 1898, the object of field work was floristic. During that time the foundations of phytogeographical work were laid, while the survey herbarium was built up and collecting continued. The work was chiefly directed toward determining the geographical distribution of species in the state, the working out of floral contrast between districts and regions, and regional limitation. Toward the end of that period, the method of study of abundance by the quadrat was adopted. The third period, from 1898 to the present, has been marked by research work in ecology and the development of improved research methods.

Dr. Heald spoke of field work in pathology. He said that, while formerly pathological investigation had been conducted almost wholly in the laboratory, the tendency at the present time was to go to the other extreme and to work chiefly in the field. He pointed out the necessary limitations upon each method of work in pathology and the relations of the one to the other.

In closing, Dr. Clements suggested a prophecy and a warning. As botany becomes broader and surer in its progress, the relative position of laboratory work and field work will be changed. The field will take the first place. The laboratory, though indispensable, will become secondary in that its chief use

will be to assist the interpretation of field facts and field experiments. For many reasons, this shifting of emphasis must be slow. Field methods must be developed and refined and students must be trained in their use. Field work demands instruments, base stations and much experience not for months but through years. In short, with these things, the field will become the real laboratory which must always be supplemented by secondary laboratories of histology, by plant houses, and the like. Each generation of botanical students is apt to feel that the beginnings of botany do not much antedate the beginning of its study of the subject. It sees and reads and does the things that are most recent and rarely dips into the past. It loses sight of the fact that development is of necessity a slow process and that most of the ideas and methods of to-day have a history. Hence, while the new generation is instructed to search diligently in the field and laboratory, it must not ignore the records of the past to be found in the books.

Following the open meeting, a regular meeting was held at five o'clock at which fifteen undergraduate students, who had been duly examined, were initiated in the preliminary degree of 'candidatus,' and four graduate students were promoted to the intermediate degree of 'novitius.' Thereafter, at six-thirty, a collation was spread in one of the laboratories to which a number of guests, members of the faculty of the university, had been invited. At the speaking after the collation, Dr. Pound presided. The speakers were Dr. Bessey, Dr. E. W. Davis, dean of the College of Arts, Dr. H. K. Wolfe, professor of educational psychology, and Dr. Bolton, professor of psychology.

PHYSIOLOGICAL ECONOMY IN NUTRITION.

IRVING FISHER, professor of political economy at Yale University, has been conducting experiments to discover whether proper mastication and enjoyment of food would produce the 'physiological economy' claimed for it by Mr. Horace Fletcher, and also whether it would lead to the use of low proteid according to the standard advocated by Professor Chittenden. The result of the experiment would seem to answer both these questions in the affirmative. The experiments were conducted with nine Yale students and lasted from January to June, 1906. Careful record of the amounts of food taken, and the constituents in, proteids, fats and carbohydrates, was kept for each man for each day. To avoid weighing at the table, the food was all weighed in the kitchen and served in 'standard portions' of 100 calories each or simple fractions or multiples thereof, so that the men merely needed to record the number of portions eaten. The proportions of proteids, fats and carbohydrates were found by means of the Mechanical Diet Indicator described by Professor Fisher in the *American Journal of Physiology* for April. During the first half of the experiment the men followed two rules only. The first was to thoroughly masticate the food up to a point of 'involuntary swallowing' with the attention, however, upon the taste and enjoyment of the food rather than upon the mere mechanical act of mastication. Any 'counting of chews' was discouraged as was also the forcible holding of food in the mouth, as experience of others, as well as the conclusions of Pawlow, had seemed to show that anything which tended to make eating a bore harmed rather than helped digestion. The second rule was to obey implicitly the leadings of appetite, both in regard to quantity of food and the choice between different foods. In order that this strict obedience to appetite might be the more easily followed, a wide range of choice of foods was supplied and no food was placed before the men which was not specially ordered by them.

This first half of the experiment, therefore, was really an experiment in natural eating, if we may assume that it is unnatural to hurry through our meals and to eat what is set before us, out of politeness, habit or limitation of choice. It was found that, as a consequence of the thorough mastication and obedience to appetite, a profound change occurred in the diet of the men. There was a large reduction in the quantity of liquids of all kinds at meals —water, tea, coffee and even soups. There was a reduction in the total daily average of

calories consumed of about 10 per cent., a reduction of proteids of about 15 per cent., and of flesh foods (meat, fowl, fish and shell fish) of about 40 per cent. During the second half of the experiment the two rules above mentioned were continued in force but a third was added. This was, when the appetite was uncertain in its choice of foods, to give the benefit of the doubt to the low proteid and non-flesh foods and to foods regarded, provisionally, as the most wholesome. This influence of suggestion was never carried however to the point of eating against appetite. This still remained supreme. Suggestion was used merely to settle cases where appetite was not decisive.

During the second half of the experiment there was a still more pronounced change in the character of the diet. Comparing the diet in June with that in January it was found that the total calories had fallen about 25 per cent., proteid about 40 per cent. and the flesh foods over 80 per cent. or to about one sixth of the original amount. Moreover the proteid had fallen to the level indicated as desirable in the previous experiments of Professor Chittenden, which is one and a half calories of proteid per pound of body weight.

Other physiological changes were noted. There was reduction in the quantity of the excretions and in the putrefactive and fermentative properties of the feces.

The body weights of the men during the first half of the experiment fell on an average of two pounds and in the second half fell further four pounds. Gymnasium tests were made to ascertain the strength and endurance of the men. It was found that their strength had remained practically constant through the experiment while their endurance increased during the first half about fifty per cent. and during the second half by as much more. A marked distinction was drawn between strength and endurance, strength being the utmost force which a muscle can exert *once* and endurance the number of times that a muscle can perform an exertion which is within its strength. Seven endurance tests were used: rising on the toes; deep knee bending; leg raising; raising five-pound dumb bells by the triceps; raising successively dumb bells of fifty pounds, twenty-five pounds, ten pounds and five pounds by the biceps; holding the arms horizontal and running. In many of these tests it was found that the will gave out earlier than the muscle; in short, that they were tests of grit, but in others it was found possible to work the muscles up to the point where they refused to contract further. Many precautions were taken to prevent any errors in these comparisons and only those records were used in the final averages in which the men were less tired in January than after the corresponding tests in June or records in which, both in January and June, the muscle was operated up to the point where it refused to contract. Even with all these precautions the improvement in endurance was found to be enormous. For instance, one of the men who in January could not raise a five-pound dumb bell with his triceps beyond the one hundred and eighty-fifth time, in June was able to do so 501 times, and another who could do the leg raising in January 50 times, in June could perform this 105 times; another who in January could lift the twenty-five-pound dumb bells with the biceps 10 times, in June could do so 27 times. The average improvement from January to June, making every possible allowance, was over 90 per cent. The men were not as stiff and sore after the June as after the January tests, in spite of the fact that they had performed double the amount of work.

So far as is known, no other than dietetic causes could have produced this result. The men led sedentary lives with less rather than more exercise than previously. They were no more regular in their habits and made no effort to live more hygienically except in the matter of diet. The dietetic factors were merely a wide range of choice of wholesome foods well cooked and appetizing, slow eating and obedience to appetite. As to which of these factors was the most important, and as to the manner in which physiologically they affected an improvement in endurance, there is much room for speculation. In the light of other facts it may at least be suspected

that one of the chief reasons for improved endurance was a reduction in proteid.

Mental tests were taken consisting of the addition of numbers, these showing slight increase in mental quickness.

A complete account of the experiments will be published shortly. It was undertaken by Professor Fisher in connection with a series of statistics which he is collecting on the subject of labor-power, especially in relation to diet, somewhat similar to the series of statistics collected by the economist Nitti some ten years ago. In communicating to the editor of SCIENCE the foregoing outline of his experiment, he has asked that any readers of SCIENCE who may be able to supply data on this subject from personal experience or other sources will put themselves in correspondence with him.

FIELD WORK OF THE SCIENCE DIVISION OF THE STATE OF NEW YORK.

GEOLOGICAL SURVEY.

Correlation Work.—The director and assistants continued the field investigations necessary to the comparative study of the New York Devonic faunas in their extension eastward. Explorations, resulting in considerable and exhaustive collections, were carried on in northern New Hampshire and Vermont, eastern Maine and in the Gaspé Peninsula, Canada. These field investigations, now completed, have brought to light a very large amount of instructive paleontological and stratigraphical data.

Areal Surveys.—The survey of the crystalline region of the Highlands of the Hudson has been continued. In the Adirondacks, a portion of the iron region of Essex County has been resurveyed and the Theresa quadrangle in Jefferson County well covered. In the area of exclusively sedimentary rocks, surveys have been made in the Lake Champlain Valley, and the following quadrangles in central and western New York have been advanced or brought to completion: Chittenango, Cazenovia, Syracuse, Geneva, Auburn, Nunda, Portage, Skaneateles and Phelps.

Surficial Geology.—Though somewhat interrupted by the absence of the geologists in charge, some advance has been made in the interpretation of the northern Hudson and lower Mohawk Pleistocene phenomena and in the survey of the morainal deposits of western New York.

Paleontology.—A discovery of singular interest is the occurrence of Eurypterus-bearing shales with a novel and extensive fauna in the Shawangunk Mountains of eastern New York. The age of the Shawangunk grit, commonly regarded as equivalent to the Oneida conglomerate (lowest Upper Siluric) of central New York has but recently been demonstrated on purely stratigraphic data, to be the probable equivalent of part or all of the Salina formations. Subsequent to this demonstration the Eurypterus fauna was found in the grit, confirming the stratigraphic deduction, as its species are in some measure those of the Pittsford shale which lies at the base of the Salina series in western New York. The fauna is distributed through nearly 700 feet of the grit deposits. The museum has been enriched by very extensive collections of these fossils. Large acquisitions have also been made from the Eurypterus localities of Herkimer County from the Chazy and Beekmantown limestones of Lake Champlain with some remarkable slabs of Cystideans and other fossils from the Trenton limestone of southern Ontario.

Economic Geology.—A careful reexamination of the iron regions and their ore bodies has been made with the definite purpose of indicating possibilities of future development. These operations have met with a result altogether unanticipated and have determined the presence of undeveloped ore deposits so extensive as to put the state in the first rank of iron-bearing regions of the country. Indeed it is now probable that no equal area contains more available undeveloped iron ore, now to be reckoned by some hundreds of millions of tons of fair to high grade ore representing a vast increase in the potential wealth of New York state.

Other metallic ore industries have also been exploited, an interesting example being the newly developed zinc deposits of St. Lawrence County. Special examination of the sand-

stones of the state have been continued and completed.

Mineralogy.—A discovery of notable interest is the location of a series of vein caverns lined with perfectly developed calcite crystals of extraordinary size. A single crystal of remarkable crystallographic completeness and of a fine amethystine tint weighs nearly 1,000 pounds and innumerable others from 50 to 500 pounds each. In habit these crystals are highly modified rhombohedra with basal pinacoids and scalenohedral faces, frequently twinned but exemplifying a common form without great modification. Probably no such development of calcites so gigantic in size and at the same time so uncomplicated, clear and well built has before been seen in this country. An extensive series of these crystals has been removed for the museum and measures have been taken to control the entire supply for the state's collections.

Caverns.—Careful exploration has been made of the caverns of the Helderberg limestone plateau for the purpose of ascertaining their relations to the existing topography and drainage. It has been possible to determine that this network of underground passages represents successive stages of work not dependent wholly on the joint systems of the region and that, as lines of drainage, these passages are to-day in a decadent stage.

ARCHEOLOGY.

For two years past options have been taken on various lands believed to carry sites of Indian villages or burial grounds, and these are excavated as opportunity affords. This year the archeologist opened a village and burial site near Ripley on the shore of Lake Erie. The encroachment of Lake Erie on this site has been so great as to destroy some part of it, this of itself aside from internal evidence indicating its considerable antiquity. One hundred and fifty graves and refuse pits were opened and from them were obtained an amazing number of all sorts of relics and utensils of this early Erie culture, stone implements and ornaments in great variety, fabrics, skin clothing, seventy pots, about half of which were unbroken, skeletons with ornaments attached and even parts of skin and flesh preserved. No site ever opened in New York has proved so instructive and so prolific in the vestigia of Indian life. The additions thus made to the archeological collections are extensive and important.

BOTANY.

Reexamination of species of Crataegus and the search for additions to fungous flora have been the chief objects of the past field season.

ENTOMOLOGY.

Protective and control measures against the San José scale, the grape root worm, tussock moth and elm leaf beetle and other insect enemies of the fruit and shade trees have been actively carried out. Special investigations upon the Caddis flies and gall midges have also been continued.

INTERCOLLEGIATE GEOLOGICAL EXCURSION.

The annual New England intercollegiate geological excursion was held on Saturday, November 3. This excursion, organized in 1900 by Yale and Harvard, has met at Holyoke, Worcester, Boston, Salem and Meriden, and has annually brought together students from all the New England colleges and many of the normal schools and high schools, participation being limited to teachers of geology and certain advanced students. The expeditions have done much to improve teaching on the subject and to develop friendly relations between the geological departments of the different institutions.

Last Saturday the excursion was conducted at Meriden, Conn., by Professor Gregory, of Yale, and was preceded by a meeting on Friday evening at which the geology of the Meriden region was described. The object of the trip this year was to study the sandstones and interbedded lavas of the Triassic formation, and special attention was given to an important 'fault line,' on which the displacement amounts to 2,000 feet. Professor W. M. Davis, who worked out the structure of the region, pointed out the topographic features which were the result of the faulting; Pro-

fessor W. N. Rice explained the Ash Bed of Lamentation Mountain, and Professor J. Barrell, the two lava flows of the second or main sheet. In addition to advanced students from colleges and teachers from high schools the following institutions were represented: Harvard, Professors Davis and Wolff, Drs. Johnson and Huntington; Massachusetts Institute of Technology, Dr. Loughlin; Wellesley, Professor Fisher; Holyoke, Professor Talbot; Williams, Professor Cleland; Brown, Professor Brown; Wesleyan, Professor Rice; Trinity, Professor Genthe; Rutgers, Professor Lewis; Yale, Professors Gregory, Barrell and Schuchert and Mr. Bowman; U. S. Geological Survey, Dr. George Otis Smith; Salem Normal School, Professor Moore; New Britain Normal School, Professor Loomis. Professor H. F. Cleland, of Williams, was appointed permanent secretary. The next meeting will be held at Providence, Rhode Island, under the leadership of Professors Brown, Emerson and Woodworth.

LOCAL ARRANGEMENTS FOR THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND THE AFFILIATED SCIENTIFIC SOCIETIES.

NEW YORK CITY having been selected at the New Orleans meeting of the American Association as the place of the next annual meeting, a notice was published in SCIENCE calling a meeting of local members at Columbia University on January 18. At this meeting plans were discussed and a local executive committee was elected as follows: J. J. Stevenson, chairman, C. C. Adams, Charles Baskerville, Franz Boas, N. L. Britton, H. C. Bumpus, Chas. A. Conant, Simon Flexner, Wm. J. Gies, Wm. Hallock, Alex. C. Humphreys, G. S. Huntington, Edward Kasner, Henry F. Osborn, C. L. Poor, Clifford Richardson, E. B. Wilson, Frederick J. E. Woodbridge, J. McKeen Cattell, secretary. This committee has held four meetings at the American Museum of Natural History. The business transacted and the preliminary arrangements for the meeting may be summarized as follows:

1. The first general session will be held in Earl Hall, Columbia University, at 10 o'clock on the morning of Thursday, December 27. The retiring president, Dr. C. M. Woodward, will introduce the president of the meeting, Dr. W. H. Welch, and President Butler will welcome the members. The usual announcements will then be made. The sections of the association will hold at 11 o'clock their meetings for organization, followed in several cases by the address of the chairman. Council meetings and meetings of organization of the special societies can to advantage be held at 9 o'clock. All the sections of the association and, so far as possible, all the national societies will meet at Columbia University on December 27 at 2 P.M. Several of the sections of the association will hold sessions in which topics of general interest will be discussed. At 8 o'clock the retiring president will give his address in Horace Mann Hall. From 9 to 11 o'clock the trustees of Columbia University will offer a reception. At 10 o'clock there will be an informal smoker in the Faculty Club.

2. On Friday the sections and the societies will hold their regular sessions. It is expected that there will be joint meetings when the same subjects are covered and that some meetings will be arranged of general interest to all members of the association. Friday evening is reserved for dinners and meetings of special societies and groups. It is also suggested that smokers and informal meetings be held on the Wednesday evening preceding the meeting.

3. The meetings will continue on Saturday with some scattering. Thus Section K and the societies devoted to the medical sciences will meet at the Rockefeller Institute, and Section G and the American Botanical Society will meet at the New York Botanical Garden. There will be a lecture at the City College at 12 o'clock, followed by a luncheon and an inspection of the new buildings. At 3:30 o'clock ten marble busts of pioneers of American science, presented by Mr. Morris K. Jesup to the American Museum of Natural

History, will be unveiled. At 8 o'clock there will be a reception by the trustees of the museum and the New York Academy of Sciences with an exhibition of scientific progress by the academy, including demonstrations and short addresses. At 10 o'clock there will be an informal smoker at the Chemists' Club.

4. The meetings will continue on Monday and Tuesday, or so long as is required by the programs, and probably several of the special societies will meet on those days. The meeting of the nominating committee will be on Monday evening.

5. The Hotel Belmont, on 42d street, opposite the Grand Central Station, will be the general headquarters. Adjoining this hotel are the Murray Hill Hotel and the Grand Union Hotel, at which the rates are lower.

SCIENTIFIC NOTES AND NEWS.

A SCIENTIFIC session of the National Academy of Sciences will be held at the Harvard Medical School, Boston, beginning on Tuesday, November 20, at 11 A.M.

THE winter meeting of Section C of the American Association for the Advancement of Science will be held in conjunction with the American Chemical Society at Columbia University, New York, December 27, 1906, to January 2, 1907. The following persons have been appointed to preside over the sections and to aid in the preparations for the meeting:

Physical Chemistry, Alexander Smith.
Inorganic Chemistry, E. H. Miller.
Organic Chemistry, A. S. Wheeler.
Agricultural and Sanitary Chemistry, L. L. Van Slyke.
Biological Chemistry, P. A. Levene.
Industrial Chemistry, A. D. Little.

Members desiring to present papers are requested to send titles and brief abstracts to one of these persons or to the secretary of the section, Professor Charles L. Parsons, New Hampshire College, Durham, N. H. To make sure of consideration, such titles should be received before November 24.

THE American Physiological Society will hold its nineteenth annual meeting during convocation week in New York City, on Thursday, Friday and Saturday, December 27, 28 and 29, 1906. The session on the morning of December 29 will be a joint meeting with Section K—Physiology and Experimental Medicine—of the American Association for the Advancement of Science, at the Rockefeller Institute for Medical Research.

THE annual meetings of the American Anthropological Association and of the American Folk-lore Society will be held in New York City, beginning on December 27, in affiliation with Section H of the American Association for the Advancement of Science.

SIR WILLIAM PERKIN has received the degree of doctor of laws from the Johns Hopkins University, and the degree of doctor of science from Columbia University. He has been entertained by the University of Pennsylvania and other institutions that he has visited.

IN addition to those engineers who were announced in SCIENCE as having been granted the degree of D.Sc. on the occasion of the dedication of the new engineering building of the University of Pennsylvania, the degree was conferred on Professor W. P. Blake. In presenting Professor Blake for the degree, Mr. Arthur L. Chase said: "We ask you to confer the degree on William Phipps Blake, because of his knowledge and experience in mining engineering, geology and mineralogy. The results of his activities have been useful to the governments of the United States, to Japan, to the state of California and to Arizona territory. For many years he has occupied a distinguished position as a teacher, and he has written a great number of illuminating books and papers on the mining of the precious metals and other technical subjects."

CAPTAIN ROALD AMUNDSEN sailed on November 8, on the Scandinavian-American steamer *Hellig Olav*, for Christiania, where the records of his magnetic observations in the Arctic will be worked out. Captain Amundsen has presented his entire collection to the Norwegian government. The new king of Norway has conferred upon him the highest decoration of the kingdom, the grand cross and cordon of St. Olaf.

ON the evening of November 3 the Geographic Society of Chicago tendered a reception and banquet to Captain Roald Amundsen on the occasion of his return from three and one half years of successful exploration in the region of the magnetic north pole. Addresses were made by the guest of honor, and by his first officer, Lieutenant Hansen; by the Norwegian consul, Fredrik Herman Gade; by the president of the society, Professor Henry J. Cox, and by Professors R. D. Salisbury and T. C. Chamberlin, of the University of Chicago.

PROFESSOR ROLAND THAXTER, of Harvard University, has returned from a year's leave of absence, a portion of which was spent in South America, and has brought back considerable collections of various cryptogams, most of which were obtained on the Straits of Magellan.

PROFESSOR WALTHER NERNST, of the University of Berlin, has returned to Germany after delivering the Silliman lectures at Yale University.

DR. SVEN HEDIN, who by order of the government was denied access to Tibet from the side of India, is making good his entry into western Tibet from Chinese Turkestan.

MR. WALTER WELLMAN and Major Hersey have sailed for New York on the French steamer *La Savoie*. The former will return to Paris in six weeks to continue his supervision of the changes in his airship. Major Hersey will accompany the Chicago *Record-Herald* expedition in its attempt to reach the Pole next summer.

RICHARD M. SHAW, a student in the medical department of the University of Pennsylvania, has joined an expedition organized by Dr. W. G. Miller, of Philadelphia, for the purpose of making explorations in Alabama and Florida. About two months will be spent in Alabama, during which a number of Indian burial mounds will be excavated, and four months will be spent in making similar investigations in Florida.

DR. HENRY S. PRITCHETT, of the Carnegie Foundation, will be the principal speaker at the thirty-fifth anniversary exercises at the Johns Hopkins University on February 22.

MR. H. YULE OLDHAM, reader in geography at Cambridge University, is giving a course of public lectures this term on 'The History of Geographical Discovery,' dealing principally with the discovery of America.

AT the annual general meeting of the British Astronomical Association Mr. F. W. Lavender was elected president to succeed Mr. A. C. D. Crommelin. Other officers were elected as follows: A. C. D. Crommelin, E. W. Maunder, S. A. Saunder and W. H. Wesley as vice-presidents, Mr. W. H. Maw as treasurer and Messrs. J. G. Petrie and J. A. Hardcastle as secretaries.

DR. R. HERTWIG, professor of zoology and comparative anatomy at Munich, has celebrated the twenty-fifth anniversary of his professorship.

DR. FRANZ MERTENS, professor of mathematics at Vienna, has received a prize of the value of 5,000 Marks, given every third year by the Berlin Academy of Sciences for the most important mathematical work.

DR. VON ELSNER has been appointed associate in the Meteorological Observatory at Berlin.

MR. N. R. GRAHAM, of the chemical department of the College of the City of New York, has secured a patent on a typewriter attachment which facilitates the writing of chemical formulas.

The government of India has granted Mr. A. R. Brown, Anthony Wilkin student in ethnology and archeology at Cambridge University, a sum of £300 to assist him in carrying on his researches amongst the natives of the Andaman and Nicobar Islands.

As the result of correspondence between Mr. Cornelius Vanderbilt, president of the Robert Fulton Monument Association, and the four surviving direct descendants of the inventor of the steamboat, these descendants have consented to the removal of the remains of Fulton from Trinity churchyard to the tomb and monument that the association is planning to erect.

Dr. Edmund Howd Miller, professor of analytical chemistry at Columbia University, died on November 8, at the age of thirty-eight years. Dr. Miller received his bachelor's, master's and doctor's degrees from Columbia University, and was promoted to be assistant, tutor, instructor, adjunct professor and professor at that institution. He was a fellow of the American Association for the Advancement of Science and has been chairman of the New York Section of the American Chemical Society. He had carried out researches on fire-assay methods, including assays of tin, platinum, etc.

The death is announced of Dr. Ernst Caesaro, professor of mathematics at Naples.

Civil service examinations are announced as follows: On November 30, for the position of laboratory assistant qualified in practical optics in the Bureau of Standards at a salary of $1,000; on December 5, for the position of aid in the Coast and Geodetic Survey, at a salary of $720; for the position of preparator of fossils in the Geological Survey, at $75 a month; for the position of psychologist in the Government Asylum for the Insane, at a salary of $1,500, and for the position of arboriculturist in the Bureau of Plant Industry, at a salary of $2,000.

The University of California has received by donation the herbarium and botanical library of Mr. and Mrs. T. S. Brandegee, of San Diego. The herbarium is one of the most important in the west, since it contains something over 100,000 sheets of carefully selected plants, mostly representative of the Mexican flora, which for many years has been Mr. Brandegee's chosen field, and of the flora of California and neighboring states, which has received careful treatment at the hands of Mrs. Brandegee. It contains the sole remaining duplicate types of many species, the originals of which were lost in the recent fire that destroyed so large a portion of the California Academy of Sciences herbarium, as well as the types of practically all the new species described by Mr. and Mrs. Brandegee themselves. Among the noteworthy sets represented are Bebb's Willows, Parry's Manzanitas and Chorizanthes, a majority of the Mexican sets distributed by Palmer, Pringle, Lumholtz, Purpus, etc., and a selection of types and duplicate types from the Orcutt and Cleveland herbaria. It is probable that no other herbarium contains so nearly complete a representation of the North American Borraginaceæ. It is also rich in Mimulus, Eriogonum and other groups in which Mrs. Brandegee has been particularly interested. The university herbarium, as now enlarged, numbers approximately 250,000 sheets, a majority of which are mounted in permanent form. The whole collection is available for study and occupies fire-proof quarters in one of the buildings recently erected on the university campus. Here visiting botanists desiring to study the west American and Mexican flora or to consult the working library of the herbarium, will be welcome and given every opportunity for research work. Mr. and Mrs. Brandegee will continue their studies at the university, where Mr. Brandegee has been appointed honorary curator of the herbarium. Mail matter may hereafter be addressed to them at the university.

The Academy of Natural Sciences of Philadelphia has recently acquired two notable zoological collections. One of these is the Gulick collection of Hawaiian land shells, which served as the basis of Rev. John T. Gulick's well-known work, 'Evolution: Racial and Habitudinal.' It contains elaborate series representing the numerous geographic and local races, not a few of which are to-day quite extinct. The other accession is the Tristram collection of birds numbering some 7,000 skins and representing upwards of 3,000 species. This is the second collection made by the late Canon Tristram, the first one having been secured some years ago by the Liverpool Museum. The present collection comprises birds from all parts of the world, but is especially rich in insular forms and in northern South American birds. Several other collections obtained by the academy during the last few years—notably the Sumatran collection, obtained and presented by Mr. A. C. Harrison, Jr., and Dr. H. M. Hiller; the

collection from British East Africa deposited by Mr. Geo. L. Harrison, Jr., and the Porter Philippine collection—have greatly increased the value of the ornithological department of the museum and the Tristram collection brings the total number of specimens up to nearly sixty thousand.

THROUGH the generous gift of Mrs. Russell, the library of the late Professor Israel C. Russell has become the property of the University of Michigan; and by her request it will be kept separate to form the nucleus of a Departmental Library of Geology. The regents of the university in accepting the gift authorized changes in the museum building—at present the home of the geological department—and in a few weeks the books will be arranged upon shelves in a new geological seminary room to be known as the 'Israel C. Russell Room' and prepared as a memorial to this distinguished geologist. The collection which thus comes into the possession of the University of Michigan is especially rich in the separate publications of geologists; and these, like the reports and bound volumes of the collection, are to be entered in the main library catalogue of the university. An appeal will be made to working geologists here and abroad in the hope that they will place upon their exchange lists in place of Professor Russell's name the name 'Russell Library,' continuing the old address, University of Michigan, Ann Arbor, Mich., U. S. A. Contributions to the collection will be acknowledged by the university librarian, promptly entered in the catalogue, and sent to the Russell Room, where they will at once be accessible to all students of geology. A similar request will be made of the directors of geological surveys and of other geological institutions, in order that the very valuable series of their publications may be kept complete. It is thought that means will be found to continue the subscription on behalf of the library to the important geological and geographic journals which were regularly taken by Professor Russell. Printed address slips for mailing or expressing publications will be supplied upon application either to the university librarian or to Professor W. H. Hobbs, in care of the university. If notified in advance, the library will generally be willing to pay the charges upon express packages. A considerable number of separate copies of several of Professor Russell's shorter papers are still available for distribution. If geologists will indicate what papers they already possess, the attempt will be made to supply the deficiencies as far as is possible.

AT a cabinet meeting held in Paris on October 30 a measure was approved providing for the abolition of the death penalty.

THE library of the late Dr. Willard Parker, containing 4,000 volumes, was formally presented to the Medical Society of the County of Kings, October 16. The presentation was made by Dr. Willard Parker, his son, who will be made an honorary member of the society.

THE Central Committee for Scientific Research on the Brain, appointed by the International Association of Academies, has recognized the Senckenberg Neurological Institute, Frankfort on the Main, as an international institute for the purpose.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of Mr. John Daglish, Armstrong College, Durham, will ultimately receive a bequest of £30,000 and the residue of the estate.

AT the University of Nebraska the wing of the new museum building is approaching completion. It is four stories high and is fireproof throughout. The 'Temple,' intended for the use of the various societies of the university, is well under way. It occupies a quarter of a city block, being nearly 140 feet square, and is to have four stories. It is built of white sandstone and bronze brick.

NEW buildings for a mining and metallurgical department at the University of Leeds are about to be erected. Plans have been approved and tenders invited; and it is expected that the new buildings will be ready by next session. The capital fund raised for building and endowment purposes as part of the £100,000 required by the Privy Council now amounts to some £75,000.

THE old Harvard Medical School, which has the assessed valuation of $596,000, has recently been sold by the university. The building will be demolished and an office building will be erected in its place.

THE eighth annual conference of the Association of American Universities will be held in Phillips Brooks House, Harvard University, on November 23 and 24. The following universities are members of the association: California, Catholic, Chicago, Clark, Columbia, Cornell, Harvard, Johns Hopkins, Leland Stanford, Jr., Michigan, Pennsylvania, Princeton, Virginia, Wisconsin and Yale.

THE fiftieth annual meeting of the Association of Colleges in New England was held in New Haven on Monday and on Tuesday, October 29 and 30. The subjects proposed for discussion at this meeting were:

Taxation of colleges, and the means of common action thereon by college authorities. (Suggested by Harvard.)

The relation of work for the degree of A.M. to the case of students whose work for the A.B. is slightly deficient. (Harvard.)

What should determine the amount and arrangement of college charges for tuition? (Yale.)

The correlation and cooperation of the departments of instruction in a college. (Brown.)

How can we prevent illiteracy in college graduates? (Brown.)

The honor system in examinations. (Williams.)

Religious organizations: their place in our colleges and universities. (Williams.)

Is hazing a thing to regulate or extirpate? (Amherst.)

What share, under existing conditions, should be allotted to the faculty in the government of a New England college? (Amherst.)

What should be the qualifications of a candidate for a special course in college? (Wesleyan.)

Is it advisable to offer a course in college to beginners in Greek? (Wesleyan.)

The abolition of material diminution of required mathematics in college, except for scientific students. (Wesleyan.)

How far can the responsibility be put upon the student body for the conduct and deportment of students. (Wesleyan.)

MR. FREDERICK A. GOETZE, superintendent of buildings and grounds at Columbia University, has been appointed dean of the faculty of applied science.

IN the department of biology, Purdue University, new appointments are announced as follows: Howard E. Enders, Ph.D. (Johns Hopkins), to be instructor in zoology; Oliver P. Terry, M.D. (Purdue, '02), to be instructor in physiology and anatomy.

WORK in sanitary and experimental biology has been introduced at Williams College under Lorande Loss Woodruff, Ph.D. (Columbia).

DR. T. C. STEPHENS, recent fellow in zoology, University of Chicago, has been elected professor of biology at Morningside College, Sioux City, Iowa.

THE following appointments have been made in the scientific departments of George Washington University: Professor of botany, Albert Mann, B.A. (Wesleyan), Ph.D. (Munich) formerly professor of botany in Ohio Wesleyan University and expert in the Department of Agriculture; assistant professor of mathematics, Paul Noble Peck, A.B. and A.M. (George Washington), promoted from an instructorship; instructor in chemistry, Walter Otheman Snelling, B.S. (George Washington), B.S. (Harvard), M.S. (Yale), 1906; instructor in mathematics, George Albert Ross, A.B. (William Jewell), A.M. (George Washington); instructor in civil engineering, Oscar A. Mechlin, B.A. (Dartmouth), C.E. (George Washington), assistant engineer, District of Columbia; instructor in mechanical engineering, A. C. Willard, B.S. (Mass. Inst.), principal, University School, San Francisco; instructor in physics and electricity, Everett W. Varney, A.B. (Bowdoin), assistant of physics, Bowdoin College; instructor in electrical engineering, T. F. S. Maguire, B.S. (Mass. Inst.); professor of nervous diseases, Charles H. Clark, M.D. (Starling Medical College), clinical director of the Government Hospital for the Insane; professor of physiology, Shepherd Ivory Franz, A.B. and Ph.D. (Columbia), pathological physiologist at the McLean Hospital, Waverly, Mass.

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE UNIVERSITY AND THE WORLD'S GREAT WORKSHOP.[1]

President Drinker, Trustees, Alumni, Faculty, Students and Friends of Old Lehigh:

IT was with a feeling of diffidence that I consented to address you on this the fortieth anniversary of the founding of your university—knowing the difficult task I should have in following the splendid men who have addressed you on former occasions, but your president, aided by some of his good friends from the great body of your alumni in western Pennsylvania, so adroitly laid the trap for me that escape was well-nigh impossible.

However, I must say that I am not at all reluctant to be found among my friends at Lehigh. For many years I have been more or less intimately associated with the men who have been telling factors in making Lehigh what she is to-day, men who have not only helped to push outward the borders of human knowledge, but have *done* things that count in the workshops of the world. The Founder's Day you celebrate must be one of very happy memory to many who are here. Could Judge Packer look upon this scene that we are permitted to witness to-day (and who can say that he does not)—could he see these splendid buildings you have completed, dedicated and used for the higher education, others that are being constructed for

[1] An address by John A. Brashear, D.Sc., LL.D., of Pittsburg, Pa., at Lehigh University, South Bethlehem, Pa., October 11, 1906.

the same purpose—surely he would rejoice with you in the rounding out of the grand scheme so long hoped for by your presidents, your board of trustees, your alumni and the many friends of old Lehigh.

I come to assure you that the good people of the western end of our state have more than a passing interest in the new life that has come to you. Of the 1,500 alumni you have sent out to do the work of the world, we have captured no less than 175 good strong men who are to-day potent factors in the great industries of western Pennsylvania; indeed, we have many of Lehigh's very best men scattered among our 5,000 manufacturing establishments where are employed more than a quarter million workmen turning out a yearly product valued at $450,000,000.

These men—your alumni—occupy no menial positions, but are holding places of honor, trust and responsibility; indeed, I know what I am saying when I tell you that many of them are at the very head of some of the most important industries of our great city of Pittsburg and its environments. Between forty and fifty of your alumni are associated in the works of the Carnegie Steel Company. Many of them —more than a score—are associated with the Westinghouse Electric Company, others with the Crucible Steel Company of America and the American Bridge Works; in fact, your graduates may be found in every important industry in western Pennsylvania.

It seems to me that you should be proud of the record of your alumni in the part they have taken in the development of the various ramifications of the great steel interests of our country, for no less than six hundred of your men have been intimately associated with it; the fact is, right here in your own Bethlehem Steel Company you have a goodly number of Lehigh men who have made their influence felt and their labors count for the very best.

But Lehigh's record is not confined by bonds of iron and steel—her men have gone into many of the varied avocations of life and have been most successful in their calling. I have in my own library some splendid volumes that have come from your astronomical observatory—records of work of the very highest type in measurements of precision—volumes which have been criticized most favorably by astronomers all over the world, and I say it with much pride that you have turned out some of the best young men from this department that now grace the astronomical departments of universities in both hemispheres. So it has been with your departments of mechanical, civil and mining engineering, chemistry and physics; and you have also graduated men who have brought honor to their alma mater as statesmen, educators, authors, editors, scientists, lawmakers, manufacturers—indeed, covering very many phases of the world's great work. Surely Lehigh may well be proud of the record of her alumni.

It may be a hobby of your speaker, but he has been of the opinion for many years that not only is it of paramount importance that every student of technology should have enough of the so-called 'humanities' in his curriculum to develop the higher manhood, and thus broaden out his vision; but, conversely, every student who may choose the humanities should get in touch with at least enough of science, of technics, to enable him to comprehend the marvelous advances in every line of human thought and industry that will surely come to pass during his day and generation.

Will not some knowledge of the starry heavens be of use to the man who is to stand in the pulpit and proclaim the mighty works of the Creator's hand? How

about the microcosm and the macrocosm in the make-up of the universe of God? Will it add to or subtract from him who is to proclaim the Word of God who has a knowledge of and can talk about these noble subjects, or shall he be content to say:

> A primrose by a river's brim
> A yellow primrose was to him
> And it was nothing more.

Did not the Master say with an eloquence that has lived through the centuries:

> Consider the lilies of the field, how they grow; they toil not, neither do they spin, and yet I say unto you that even Solomon in all his glory was not arrayed like one of these.

I firmly believe that every student whose purpose is to follow some one of the professions will have a more successful and a happier life by absorbing at least enough of science, of technics if you please, to broaden out his views, as a knowledge of the humanities will surely do for the technically-trained student.

In an address to the students of the Sheffield Scientific School my friend, Col. H. G. Prout, made this remark, "Scientific study may in itself be a great expander of the imagination and I venture the assertion that the study of chemistry and biology, machine design, or analytical geometry, geology or astronomy, is as quickening to the imagination as the study of Greek or Latin grammar, moral philosophy or rhetoric, as any formal study of English literature."

Some Founder's Day I think you could not do better than to have read before you the splendid address of that splendid man, Eckley B. Coxe, which was delivered at the Montreal meeting of the American Association of Mechanical Engineers, of which he was then president. I had the great pleasure to hear that address on 'Technical Education,' and to you who knew the man I need not say that it made a deep and lasting impression upon my mind. It was a mighty sermon from its opening to its closing sentence, showing a most profound knowledge of the whole subject. Surely Lehigh was honored by the association of Eckley B. Coxe as a member of its board, and as a noble patron who had your best interests at heart.

Other names have graced your roll of honor, some of whom have passed over to the 'summer land of song'; yet we can rejoice to-day that some of the old guard are still with you, lending a helping hand to lift Lehigh to a still loftier plane in the domain of higher education.

As a citizen of Pittsburg I am here to-day to rejoice with you that *my* friend of a quarter of a century, and *your* friend of to-day, Andrew Carnegie, will from this time on have his name inscribed in your annals, in the hearts of your undergraduates and alumni and all that have the interest of your university at heart, as a friend and patron.

It was a joy to me to learn that he had made it possible to build the dormitories you have needed so long, and I must congratulate your president and also one of his co-workers in our end of this good old commonwealth in having secured the friendship and patronage of this friend of science; no one knows better than he who addresses you what the friendship of Andrew Carnegie means.

We Pittsburgers also have a Founder's Day, and our next one will commemorate his grandest and, we think, one of his greatest gifts to the world, namely, the splendid institute in which the arts, the sciences, music and literature will find a home and be fostered, and with this we shall also commemorate the founding of the great technical school, which has already nearly fifteen hundred students within its

walls, with thousands more begging for admittance, which we expect some day to take care of through Mr. Carnegie's munificence. Surely Lehigh can rejoice with us on our Founder's Day, for we hope to keep in close touch with your university. You need us. We can not do without you. We have already captured some of your good men for our technical school, perhaps we can reciprocate in the future, for as yet we are but a year old.

And now, lest I weary you, let me hasten to discuss the theme I have chosen for my address, namely, 'The University and the World's Great Workshop.' Of course, I shall speak only of the modern university, totally dissociating it from the scholasticism of the middle ages.

In a recent and very excellent article by Professor Edward Sisson, of the University of Washington, on Francis Bacon and the modern university, full credit is given to this learned man, as being the founder of the universities of to-day.

I quote one or two paragraphs from the article referred to that are apropos to my theme:

Bacon says: "I may lament that no fit men have been engaged to forward those sciences which yet remain in an unfinished state." Professor Sisson, commenting on this remark of Bacon, says:

> The sciences which Bacon knew have been advanced to a plane far beyond the highest imaginations of even his great mind and new regions of knowledge have been opened of which he could not dream.
>
> Even more significant is the fact that we have given up believing in the possibility of a *finished* science! All sciences are unfinished and it therefore becomes the duty of every devotee to labor for their advancement. The universities, after centuries of inertia, have at last waked up, or rather, vigorously aroused to their duty to be creators as well as conservators of the store of knowledge.
>
> The use of Latin as an exclusive means of communication and the worship of Aristotle as the source of final authority upon all questions were the two great prerogatives of the medieval universities. All this has been changed, and we live in the dawn—yea, in the broad light of a better day.

There was a time when a university education did not stand for what it does now; indeed, I am sure that there are those in this audience who can remember when the graduates of our universities, particularly those who received a technical education, were looked upon with doubt or even suspicion when they applied for a position in any of our manufactories or workshops. Perhaps it was in some instances in the earlier days a well-founded suspicion that the applicant had surfeited himself with book learning and had no knowledge whatever of the practical side of the position he sought. Happily that day has passed and the time has come when our mills, factories and workshops, in fact every important industry, appeal to our universities and technical schools to furnish them with men who have not only been taught to think, but to *do* things.

Setting aside for the moment the purely professional schools, where would the great industries of our land be to-day without the men who have come from our universities and technical schools?

I know I lay myself open to criticism by those who will say that many of our great industries have been originated and developed by self-made men, men who had only the most meager education to start with. Certainly we must grant all this, but let us take as an illustration that Nestor of the steel industry in America—your honored citizen—my friend John Fritz, a man loved by everybody on earth and in heaven. Did he not go through mighty struggles, struggles that no man will ever know but himself; did he not have to master the very problems which is the province of the university to teach your students? True, you

can never give them that which comes only with the experience this splendid man has passed through, but you can and do train them so as to eliminate the empiricism that handicaps the man who does not possess what you give to your graduates.

I know I can say without fear of contradiction that no man knows better the value of the higher education than just the kind of man I have spoken of; I need not dilate upon this subject, the witnesses are all with me. Let it be said to the honor of these self-made men, these men who have made a commercial success in their business career, that you will find their names on record as the very best friends of education; they are the men who have given millions to build up and foster the universities and technical schools of this good land of ours. Not only has your patron, Mr. Carnegie, contributed many millions to higher education, but he has gone farther by endowing original research and also providing a fund to care for the men who have borne the heat and burden of the day as teachers in our educational institutions. What a splendid work for one self-made, self-educated man to do. Other names I could mention who have done nobly for the cause of education, and when the book of God is written Ben Adhem's name will not be the only one recorded of those who loved his fellow men.

It is a great pleasure to me to be honored to-day with the presence of my long-time friend, Mr. Charles M. Schwab, who has done so splendidly for technical education in our great manufacturing town of Homestead; nor did his interest cease with this good work, for I know what he has done for State College, for the Western University of Pennsylvania in Pittsburg and kindred institutions. He knows and appreciates what there is in the hearts of his workmen and how they love to learn of the good and beautiful things in this life that they can and should have a share in enjoying. All honor to such men.

Every industry, every scientific pursuit, every calling of to-day demands the best education that can be given by the best men in the best schools, and the magnificent results that have crowded in upon us in the last half century are largely due to the masterly work done in our institutions of higher learning.

Let us examine for a little while some of the results coming to us from university men. In the great field of astronomy and astronomical physics we have been brought almost to the borderland of the infinite. In the last quarter of a century, discovery after discovery has been made and so many new facts brought to light that no one mind is capable of comprehending them all.

In the domain of solar physics we have thrust our spectrobolometers into the very depths of the sun's photosphere. With our spectrographs we have taken hourly records of the terrific storms that rage upon our great luminary. That record can be made to tell us the very elements that go to make up the solar disturbance. The sun's energy has been measured and its source discovered—not in the old-time meteoric theory of accretion, but we now know that the shrinkage of the solar envelope is all sufficient to keep up its temperature for at least ten millions of years to come, should no new source of its energy be discovered.

The university man has also shown us that in all probability our sun is a variable star, with a variation of perhaps ten per cent. in its radiant energy. Some day he will tell us its period of variability as we now know with absolute certainty the period of many variable stars in the heavens. The university man has also measured the radiant energy coming to us

from our sun, and while we receive only about one twenty-two hundred millionth of that which is sent out from our great luminary, we know that it has conserved, and this old earth has stored up untold billions of 'units of energy' that we are now utilizing to do the work of the world. Some day this storage battery will run down and we must either renew it or go to the original source for our energy. The university man has been on the alert and already he has tapped the wires of the great solar dynamo by harnessing old Niagara's waters as they tumble over the mighty rocks—lifted there by the sun's potent forces.

We have also learned that the earth's atmosphere is so constituted that it conserves the long waves of energy coming from the sun, which if it did not do, organic life, as we know it, would be impossible on our globe.

Our medieval astronomers taught us the stars were all fixed, immovable in the heavens. The doubting student came along in later years, and with his instruments of precision soon discovered there were *no* fixed stars. He could readily measure their movements across the line of sight, but when moving away from or toward us, his instrumental equipment utterly failed him. Then came the university man Doppler to his help, with the principle of variable wave motion now known as Doppler's principle; then came the telespectroscope, by the use of which this principle could be applied; and now our astronomers are rapidly gaining a knowledge of the motion of all the more important stars in the heavens. With this knowledge has come to us the interesting fact that our own solar system, our sun, our earth and our sister planets are all moving through the universe at the rate of about one million and eighty thousand miles in twenty-four hours, or twelve and one half miles a second, in the direction of the constellation of Hercules.

But the end is not yet. Your university men could not reconcile certain minute displacements of the stars that were of a rhythmic character and they began to suspect that this old globe was not stable, that it had a wobble, if you please, like a top after it had passed its 'sleep.' Here you will pardon me when I tell you that one of your best men, with a big brain, but rather inadequate equipment, was one of the pioneers who undertook to solve this abstruse and difficult problem, and be it said to the honor of Lehigh, the continuation of this work by this man has settled the question to a degree of precision never dreamed of when he commenced his work. Another difficult problem has been attacked by your astronomers at Lehigh, namely, the constant of aberration, the solution of which speaks for itself. I should like to tell you more about it; indeed, I should like to mention the names of some of your men who have made epochs in the world's work, but I dare not, lest I overlook some who should be on the roll of honor. Suffice it to say that the published results of these long, difficult and patient researches have already become classic in the annals of astronomical literature.

Patience, patience is the watchword of a sage,
Not to-day, nor yet to-morrow, can complete a perfect age.

Other volumes on double and binary stars have recently been given to the astronomical world by one of your alumni and have found immediate recognition as works of the highest value. I am informed by your president that still another volume is ready for publication, the results of observations made at your observatory, the gift of one of your oldest and most honored trustees. Surely you have a right to be

proud of your record in this the most exact and perhaps the most fascinating of all the sciences.

I am sure, however, that you as university men are all interested in the great progress made in this noble science by your colleagues all over the world. American astronomers coming from American universities are gathering, constantly gathering, new sheaves from the stellar fields, fields that seem to be perpetually ripening for the harvest.

It was but yesterday we heard of a new star whose brilliant light burst forth in the heavens, not when we first caught a glimpse of it, but may be a hundred years ago, and it is so far distant that its light, flashing across the stellar depths at the rate of 186,000 miles per second, has taken all these years to reach us.

Placing the slit of our telespectroscope upon the new star, we observe the awe-inspiring phenomenon 'of a sun in flames.' Our inference is that there has been a collision between two stellar worlds somewhere in the universe, and now we witness the elements 'melting with fervent heat' perhaps a hundred years after the awful cataclysm has taken place. A year later the light of that brilliant star had faded from mortal vision, but the astronomical camera, penetrating far deeper into stellar depths than the human eye, even when aided by the telescope, reveals to us the story of a disintegrated world, now a mass of nebula, ready to go through its long evolution, possibly in countless millions of years to become a star again.

'Tis a fascinating theme upon which I could dwell for all the time at my command, but "I must come back to this good old world again, where the birds still sing and the fields yet are green, surely the place of all we have found, the best suited for our dwelling place."

For more than a quarter century your speaker has had the privilege of knowing and associating with the men who have been wresting the secrets of the heavens from their hiding places. The 'new astronomy' has taken the place of the old, and marvelous have been the discoveries made by these men, university men, in this beautiful science.

But with astronomy as with all other sciences there are as yet many problems unsolved, it is an *unfinished* science and the storehouse of heaven is still full of treasures for the searcher after truth.

Ye quenchless stars; so eloquently bright,
Untroubled sentries of the shadowy night,
While half the world is lapped in downy dreams,
And round the lattice creep your midnight beams.
How sweet to gaze upon your placid eyes
In lambent beauty looking from the skies.

There are some problems in astronomy that invite the cooperation of the physicist and the engineer. I have already mentioned the fact that the physicist has utilized the solar energy very nearly at headquarters, but that source, namely, of the great waterfalls, has its limits.

For many years I had the honor to be associated with the late Professor Langley in his studies of the radiant energy from the sun. Many attempts were made to conserve this energy direct without the use of concentrating lenses or mirrors, one of which gave great promise of success. Some day it will be done. Perhaps there will come a time when our fuel supply will be exhausted, then why not capture the original source of energy and make it do our bidding. Professor Langley calculated that it would require all the coal of all the coal fields of Pennsylvania to keep up the energy of the sun one thousandth of a second.

When we learn that the solar energy, if conserved, would approximately equal a horse power for each square meter of

the earth's surface for every twenty-four hours, we may surely consider it a problem worthy of profound study by our scientific investigators.

But I dare not go farther in this interesting subject. I shall only add, if ever the desert is 'to blossom as the rose,' utilization of the direct energy of the sun on the desert wastes will bring to us a realization of the prophetic vision.

What has the university done for us in the domain of the physical sciences? Here we open up another field of unlimited acreage, rich in revealed and yet undiscovered treasures.

Eighteen years ago I was the guest of Professor Dewar at the Royal Institution in London. Among the treasures of that historic laboratory I was shown the first safety lamp made by Sir Humphry Davy and after I had examined it to my heart's content, my friend placed in my hand the first induction coil made by Michael Faraday in 1841. Professor Dewar remarked as I examined the precious, though crude piece of apparatus, 'That is the father of all the dynamos and motors of the present day.' This was eighteen years ago. What marvels in electrical science have been developed in this short interval. One has only to walk through the great Westinghouse works at Pittsburg, or the General Electric, at Schenectady, to see the magnificent dynamos and motors that are the direct evolution of the Faraday induction coil.

Follow these finished machines to Niagara or the great power plants driving electric cars over a vast network of lines that already cover thousands of miles, both urban and suburban, and the end is not yet. I dare not undertake to predict what surely will be done in the very near future by the aid of this powerful ally of man, but I do know that for more than a double decade the university men have been all-important factors in this wonderful development of electric machinery. Go with me through the Westinghouse Electric and Manufacturing Works at East Pittsburg—and what do you find?

I can say from personal knowledge and contact with the men that are doing things in that great center for the output of electric machinery that a very large proportion of those connected with the testing laboratories, the experimental shops, in short, all scientific departments of this typical American workshop, are dominated by graduates of universities.

I am sure it would delight any of your men of Lehigh to spend an evening with the Westinghouse Club. I do not know of any place on earth among men where I have felt a greater inspiration than in talking to these young college graduates, saturated as they are with a love for their chosen pursuit. Here are gathered from four to five hundred men from the colleges and universities all over the land. They are here not only to hear lectures on the purely scientific side of their work, but to learn of men, of methods and other topics so necessary in modern institutions, and I am glad to say that the ethical relations of this splendid body of men are of immense value in their life work.

While writing the last paragraph I thought to call by telephone my friend, Charles F. Scott, who for a long period of years has been the chief electrician of the Westinghouse interests. In my conversation with him I was informed that when he came to the Westinghouse works eighteen years ago there were only four or five college men besides himself in the entire establishment. You will be surprised when I tell you that of the young men who graduated from colleges and universities last

June, two hundred and twenty-five secured positions in this great establishment.

I do not argue here nor do I wish it to be understood that as soon as a graduate has secured his diploma he is ready to take a position as a full-fledged astronomer, electrician, engineer, chemist or other position for which the university has prepared him, but I do say and believe that the earnest student will in his three or four years become so well grounded in the fundamental principles taught him that a very few years of practical work will place him as far along as the self-made man after half a lifetime of hard, hard struggle to gain such knowledge. There are noble exceptions to this statement, but they are all too rare.

A number of years ago I was invited to a luncheon given by the friends of Rose Polytechnic Institute, of Terre Haute, to a body of scientific men. Richard Thompson, so well known as 'Old Dick' Thompson, who was Secretary of the Navy under President Hayes, was an honored guest, and when called upon for a speech, gave us this interesting experience that happened when he was a member of congress from that district in 1844.

He with his colleague from the state decided that year to go to New York before going to Washington. At the hotel he found several congressmen from the east. The day after his arrival he was asked by a member from Massachusetts if he would not go across the way and see a machine invented by a man by the name of Morse, by which, it was claimed, he could send a message from Washington to Baltimore in less than a second of time. You may be sure we were all deeply interested in the old man's story as he stood before us with his flowing white hair. "I saw the machine," he said, "and after Mr. Morse described it to me, he very kindly said, 'If you will ask me a question I will answer it through the ten miles of wire I have placed through this house.'

"I asked him," said Mr. Thompson, "who would be the next President of the United States. Immediately there came the message on a little paper ribbon, and the answer was *Henry Clay!*"

Mr. Thompson replied that 'he knew nothing about the machine, but he liked its politics,' and promised to vote for a subsidy to put a telegraph line between Baltimore and Washington. He then told us that he voted for the $25,000 asked for by Mr. Morse, as did also his colleague. At the next election he was elected by 'the skin of his teeth,' but his colleague was defeated because he had *wasted the public money.* I need not enlarge on how Morse lost his signals by laying his wires underground, how Ezra Cornell, the founder of Cornell University, came to his rescue and enabled him to place his wires upon poles, and that one of the first messages that came over the wires was the announcement of the result of the election of the President—but it was *not* Henry Clay.

This story is recorded here solely for the purpose of showing how great have been the results brought about in telegraphy, largely due to the work of college men who have evolved it to such a degree of perfection that it now answers almost every demand made upon it, exacting as they are.

I was a guest at the laboratory of my friend Professor Rowland some years ago when he was developing his system of quadruple telegraphy, sending four messages both ways over one wire and printing the messages in letters of the alphabet. Your restless scientific investigators, not satisfied, have taken another step forward and are now sending electric waves across old ocean without the conventional wire. Some day they may girdle the earth in this

way—who can say it will not come to pass?

Again, your physicists, unsatisfied with the worlds of knowledge they have already conquered, earnestly seeking for others to vanquish, have brought to light a new form of energy, which they call radioactivity. They seem to have well nigh demolished the Daltonian atom as the ultimate particle of matter, and now they talk to us of ions, of electrons which we laymen are permitted to call corpuscles.

We learn from these men of the university that an atom of hydrogen can be broken up into nearly a thousand corpuscles, an atom of mercury into 200,000 corpuscles, that the atom of radium has stored within it an energy of which our older science did not dream.

Furthermore, our advanced physicists, or at least some of them, have relegated matter to a new field, and they tell us that negative electricity is matter, *i. e.*, that electrons and matter are intercontravertible terms!

Taking these wonderfully interesting theories, combining them with Arrhenius's theory of the pressure of waves of radiant energy from the sun, a new, a beautiful solution comes to us of the origin of the sun's corona, of the zodiacal light, of comets' tails—of the aurora and all correlated phenomena. Surely we appear to be bordering on Kantian transcendentalism when our physicists have reached such dizzy heights.

Lord Kelvin says of the atom: "If we raise a drop of water to the size of the earth and raise the atom in the same proportion, then will it be some place between the size of a marble and a cricket ball."

If you fill a tiny vessel one centimeter cube with hydrogen corpuscles you can place therein, in round numbers, five hundred and twenty-five octillions of them. If these corpuscles are allowed to run out of the vessel at the rate of one thousand per second it will require seventeen quintillions of years to empty it. Such a computation seems almost like trifling with science, indeed apparently trifling with the human intellect, but it is with these subtle theories that our physicists are wrestling, delving into the innermost chamber of the infinitely minute, to build for us, upon the most stable foundation, the macrocosm of a universe.

Lehigh has not been slow in its department of physical science, and her alumni can well be proud of the splendid set of text-books on physics that have come from within her walls.

But I dare not dwell longer on this fascinating theme, or I shall lead you into a maze from which there is no egress.

I have now taken so much time that it is impossible to give more than a brief review of other fields of work which have been so well cultivated by the university men of the past quarter century.

Chemistry, that all-important science—so closely related to every industry—be it of the farm, the workshop, the sanitation and water supply of cities, aye a thousand and one things in which the comfort and conveniences of life are concerned, the university man has taken hold of and developed to an astonishing degree. In one of these phases of the chemist's work your own past president Drown took a great and abiding interest, namely, that of the water supply of towns and cities. At the New Orleans meeting of the American Association for the Advancement of Science, held in January of this year, Professor Kinnicut, of the Worcester Polytechnic Institute, paid a high tribute to the great value of President Drown's labor in this field of research.

Read over the list of famous chemists of later years, such men as Hoffman, Perkin,

Raoult, Draper, Barker, Dewar, Prescott, Ramsay, Remsen, Morley, Atwater, Clarke, Drown, Baskerville, Cooke, Mallet, Gibbs, Moissan, Mendeléeff, Meyer, Oswald and a host of others. In quoting these names I take no glory from the older chemists—Lavoisier, Berzelius, Dalton, Dana and their colleagues.

Nearly all of this honored list who have passed away were university men. Those who are still with us are university men. You chemists know what they have done for the world's work; indeed, it would seem to me an easier task to write of what they have not accomplished rather than what they have done. We need only look at the marvelous achievements of Raoult and Dalton in molecular and atomic chemistry, of Morley in the same field, of Hoffman and Perkin in the coal-tar derivatives, of Ramsay's researches on the new gases in the atmosphere, of Dewar and his assistant, Travers, in the liquefaction of gases and other most valuable and interesting investigations made by them.

Chemistry and the university are to-day inseparable and it is beyond the ken of man to prophesy what discoveries these men of your schools will bring to us in the years to come.

In the domain of mechanical engineering, structural design and kindred studies, Old Lehigh stands as the peer of any institution in the land. This you may consider as flattery or unjust praise from your speaker, but the facts I have quoted in the beginning of this address are surely evidence enough to prove what I now say, and in giving you this meed of praise I do not wish to detract from the good work done by your sister colleges east and west of the Alleghanies. All are doing a noble share in the engineering work of this busy era of steel bridges, steel buildings, steel structural work of every conceivable shape and form; surely in this age of steel there is a call for the university man such as there never has been before and he has not been found wanting.

Text-books on engineering coming from within the walls of Old Lehigh are works of the highest standard, and your sister colleges have not been slow to adopt them.

Engineering is now so closely related to all sciences that the astronomer, the physicist, the chemist, the geologist, all must come to him for help in their time of trouble and he has not failed them. The electrically driven locomotive, the wonderful turbine engine, are coming to stay; they are the results of his handiwork—what shall we look for next?

Mathematics as the handmaiden of all the studies I have enumerated, has a firm foundation in our American institutions of learning. Bartlett has well said that 'the man endowed with the priceless boon of a mathematical knowledge possesses the key to the external universe.' I need add nothing further. Bartlett's saying may be adopted as a maxim rather than a postulate.

I have but few words to say of architecture, geology, biology and kindred studies, for I have lingered too long in this fairy land, in these workshops of the world, to tell you what the university man has done in and for them, but while geology has long been taught in our schools of higher learning, it is only of late years that architecture has been taken up in this country and made a study of the importance it should be, and that newest of all studies, biology, is now making deserved inroads into the curricula of the best colleges of the land. While it is the newest of sciences, it seems to me that it opens up one of the most important and valuable lines of research in the whole realm of scientific investigation because it is so inti-

mately associated with all that pertains to organic life on this old round world of ours.

The immortal Darwin gave it a mighty impetus when he presented to the world his doctrine of natural selection, and the researches of Brooks in our own country place us on a high plane in this beautiful study. Some day the world will be startled by the results of biological research.

Perhaps the most remarkable discovery recently made in embryology, a branch of biology, is that we can trace the evolution of a species through its development in the embryo, that is to say, the very beginning of the embryo is identical with the most ancient form; throughout its development we see its evolution to its present condition. Koch's discovery of the bacillus of tuberculosis made another epoch in the science of biology.

Brooks has said: "It may be some day we shall be able to construct a living organism by the combination of the proper elements." Atwater has trodden upon almost forbidden ground in his remarkable investigations of the calorific value of foods in the human subject—indeed, has gone so far in this splendid research that we may dare hope some day to measure the food value of a thought.

I am aware, as already remarked, this is treacherous ground upon which to build a solid foundation, but the better day has come when the earnest seeker for truth is no longer hindered in his onward course by that ancient barrier 'hitherto shalt thou come and no further.'

In the broad light of the twentieth century the investigator, the university man, untrammeled by fear, save the fear of error, will rise to heights of knowledge never dreamed of in our philosophy.

I verily believe that the storehouse of God's truth is like unto the 'widow's cruse,' take from it as we may, it will never be emptied of its rich, its priceless treasures.

To-day we are but learning single notes. To-morrow we shall blend them into chords. The hour will chime when all humanity shall know the law of harmony—when every note in every chord shall find its part in the sublime oratorio of universal life.

JOHN A. BRASHEAR.

SCIENTIFIC BOOKS.

Outline of the Evolution of Weights and Measures and the Metric System. By WILLIAM HALLOCK and HERBERT T. WADE. The Macmillan Company. Price, $2.25.

THE science of metrology in its evolution has been regarded by many as furnishing the best means of tracing the history of the exact sciences. If this be true, we should welcome this carefully prepared treatise by Hallock and Wade—men fitted by taste, training and experience to write upon this topic.

We have here presented a systematic general history of weights and measures, the scientific methods by which units and standards have been determined, the correct standards by which the units are represented, and the present aspect of modern systems of weights and measures together with the difficulties and advantages involved in any proposed change.

A work of this sort is especially opportune just now when a determined effort is being made to introduce the metric system in this country. It will give much useful information to help those in doubt to decide whether a change in our metrology is advisable or not. Whatever the personal views of the authors are on this subject, they have wisely refrained from giving them undue prominence.

The work contains chapters on the beginnings and development of the science of metrology, origin and development of the metric system, extension of the metric system throughout Europe and elsewhere, weights and measures in the United States, the metric system in the various arts and trades, electrical units, standards and tables of useful constants and equivalents.

Extensive foot-notes point the reader to further sources of information and a full index adds to the value of the book as a work of reference.

This book can well be declared the most complete and most authentic work extant on this important subject and it should be read by the student of physics to whom a knowledge of units and standards is most necessary, as well as by all who wish to be well informed in regard to this interesting topic.

A thorough test has proved that every recognized authority has been consulted and more than one forgotten pioneer in metrology has been given due credit for his contribution to the science. On the whole the book can be commended without reservation and the authors are entitled to our best thanks for placing in compact readable form facts that are accessible to the few and obtained by them after long and tedious research.

J. H. GORE.

Notes on Electrochemistry. By F. G. WIECHMANN, Ph.D. 5 x 9 in., pp. vi + 144. Price, $2.00. New York, McGraw Publishing Company. 1906.

The aim of the author, as expressed in the preface, has been to give 'a clear and concise presentation of the general principles which underlie electrochemical science,' 'to offer a general survey of the subject, to serve as an introduction to its study and to aid in the securing of a proper understanding and appreciation of the work along individual lines.'

In pursuing this aim, the author has devoted seven pages to general principles of science, fourteen to general principles of electrical energy, nineteen to electrochemistry proper, fifteen to electrolytic dissociation, seventeen to electrochemical analysis, forty-six to electrotechnology, and ended up with a name and subject index. Each chapter is prefaced by a list of the most important literature on its particular subject.

We differ in opinion from the author concerning the classification of electrotechnical processes; his division into direct-action and indirect-action processes seems to us to be illogically worked out, at least as far as regards placing 'electrodeposition from fused electrolytes' among the 'indirect action' processes. On page 125, line 6, the accidental omission of 'not' makes the sentence express the reverse of the facts concerning the first news of the manufacture of calcium carbide. There are a few other shortcomings really not worthy of mention, in view of the high standard of excellence and accuracy prevalent in the book.

The plan of the work is admirable, it is carried out in a masterly manner, and the author has produced an introduction to electrochemistry which most satisfactorily fulfills his objects, as quoted above. The style is clear and crisp, the information of a high standard of reliability and surprisingly up-to-date. The balance is excellent. For student, technologist, general scientist or man of affairs, it can be highly commended as a trustworthy, satisfactory and inspiring guide into electrochemistry.

JOSEPH W. RICHARDS.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Experimental Zoology, Vol. III., No. 3 (September 1906), contains the following articles: 'Locomotion of Amœbæ and Allied Forms,' by Oris P. Dellinger.

Amœbæ and Difflugias are studied from side view as they creep along the polished edge of a glass slide. From such a view the points of attachment and support which furnish the key to their locomotion are easily seen. All forms studied alternate the points of attachment and pull and squeeze themselves along. 'Light Reactions in Lower Organisms. I. *Stentor Cœruleus,*' by S. O. Mast. 'The Influence of Light and Heat on the Movement of the Melanophore Pigment, especially in Lizards,' by G. H. Parker. A study of the color changes in the skin of the horned toad shows that the so-called reversed color changes of certain lizards, Stellio, Uromastix, etc., are probably temperature reactions and not light reactions, and leads to the conclusion that in all melanophores and other like pigment cells, whether they are in the skin or the eyes of the vertebrates or

invertebrates, the general rule seems to hold that light and low temperature induce a distal migration, and the absence of light and high temperature a proximal migration of the contained pigments. 'Some Reactions of Caterpillars and Moths,' by Alfred G. Mayer and Caroline G. Soule. Larvæ of *Danais plexippus* are negatively geotropic, and also positively heliotropic to ultra-violet rays. These reactions serve to maintain them high up upon their food plant, and to prevent their wandering away. Caterpillars have no associative memory lasting more than one and a half minute, and they do not learn a labyrinth. Normal gipsy moth females select against males if the latter be deprived of wings, but if the females be deprived of sight they do not select against such males. In moths there is no sexual selection in respect to color. 'Modifiability in Behavior. II. Factors Determining Direction and Character of Movement in the Earthworm,' by H. S. Jennings. This is an analytical study of the various factors, internal and external, which decide how the earthworm shall move at a given moment. The matter is found to be extremely complicated.

SOCIETIES AND ACADEMIES.

THE AMERICAN MATHEMATICAL SOCIETY.

The one hundred and thirtieth regular meeting of the American Mathematical Society was held in New York City, on Saturday, October 27, 1906, thirty-three members being in attendance. President W. F. Osgood presided at the morning session, Ex-President T. S. Fiske at the afternoon session. The council announced the election of the following persons to membership in the society: Professor A. F. Carpenter, Hastings College; Dr. H. M. Dadourian, Yale University; Mr. T. E. Gravatt, Pennsylvania State College; Rev. A. S. Hawkesworth, Allegheny, Pa.; Mr. H. R. Higley, Pennsylvania State College; Dr. Mario Kiseljak, Fiume, Hungary; Dr. Emanuel Lasker, New York, N. Y.; Professor Ernst Lebon, Lycée Charlemagne, Paris; Dr. R. L. Moore, Princeton University; Mr. W. P. Russell, Pomona College; Professor J. H. Scarborough, State Normal School, Warrensburg, Mo.; Mr. L. P. Siceloff, Columbia University; Professor Cyparissos Stephanos, University of Athens. One application for membership was received. The total membership of the society is now five hundred and fifty-eight.

A list of nominations of officers and other members of the council was adopted and ordered placed on the official ballot for the annual election at the December meeting. A committee was appointed to audit the treasurer's accounts for the current year.

Professor W. F. Osgood tendered his resignation from the editorial committee of the *Transactions*, finding it impossible to assume the burdens of the office. The vacancy was filled by the appointment of Professor H. S. White.

The following papers were read at the meeting:

S. F. Richardson: 'Note on poristic systems of polygons.'

R. D. Carmichael: 'Multiply perfect numbers of four different primes.'

Arthur Ranum: 'On Jordan's linear congruence groups.'

Beppo Levi: 'Geometrie projettive di congruenza e geometrie projettive finite.'

Charlotte A. Scott: 'Note on regular polygons.'

Max Mason and G. A. Bliss: 'Some problems in the calculus of variations in space with variable end points.'

Edward Kasner: 'Note on the transformations of dynamics.'

G. A. Miller: 'Groups of order p_m containing exactly $p+1$ abelian subgroups of order p^{m-1}.

G. A. Miller: 'The groups in which every subgroup is either abelian or hamiltonian.'

The San Francisco section of the society met at the University of California, on Saturday, September 29, 1906.

The next meeting of the society will be the annual meeting for the election of officers on Friday and Saturday, December 28–29, 1906. The Chicago section will also meet during the Christmas holidays.

W. H. Bussey,
Assistant Secretary.

THE AMERICAN PHILOSOPHICAL SOCIETY.

A stated meeting was held on November 16, 1906, at 8 o'clock. Professor Harry F.

Keller read a paper on 'Alcoholic Fermentation in the light of Chemical Investigation.'

DISCUSSION AND CORRESPONDENCE.

CORRESPONDENCE RELATING TO A STUDY OF AN AREA OF CRYSTALLINE ROCKS IN SOUTHWESTERN NEW ENGLAND.

TO THE EDITOR OF SCIENCE: I have recently resigned my position upon the staff of the United States Geological Survey for reasons which are, I believe, of some interest to geologists throughout the country. I am, therefore, led to request the publication in SCIENCE of the letter in which my resignation was tendered.

American geology has furnished many knotty problems for solution, and workers within the same or neighboring fields have not infrequently and quite naturally come to hold different interpretations of the same facts. In more than a single instance during the present administration of the survey, the geologists of the country have known that such alternate views were held and shortly thereafter have learned that a 'conference' had been held and the problem quite expeditiously 'settled.' The methods by which such forward strides have been taken can hardly fail to interest those who have the advance of science really at heart.

WM. H. HOBBS.

UNIVERSITY OF MICHIGAN,
ANN ARBOR, MICH., Nov. 2, 1906.

DR. C. D. WALCOTT, Director,
U. S. Geological Survey,
Washington, D. C.

Sir: I have the honor to resign my commission as assistant geologist of the United States Geological Survey.

My connection with the geological staff of the survey has now extended over more than a score of years, and this action is taken after much deliberation and as a protest against the arbitrary and overbearing administration of your chief executive, the geologist in charge of geology. Permit me, therefore, to briefly review for your consideration the later developments of my official work in their relation to survey administration.

As you are doubtless fully aware, during almost the entire period of my connection with the survey my investigations have consisted of a virtually independent study of the structural geological problems offered by an area of crystalline rocks in southwestern New England. The history of American geology shows that this region is, perhaps, the most complex and obscure of any that has been studied, and the divergence of views reached by different workers and the obstinacy which in the past has characterized the defense of each, have caused it to be generally known as the 'Battlefield of American Geology.'

My earlier studies within the district followed conventional lines, and I found after repeated trials that the body of data collected could not be brought within a system so as to fit the accepted theories. Urgent requests from the office of the director to prepare my results for publication, I was obliged to meet with the statement that I was not yet ready to publish.

In the continuation of the areal mapping southward I encountered during the season of 1899 the small area of Newark rocks lying within the valley of the Pomeraug River of Connecticut and outlining a basin which was found to be intersected by an intricate network of nearly vertical faults. Believing that in this basin lay the hitherto unsuspected key to the structure of the larger district, much attention was given to a study of the faults in their relation to each other and to topography and hydrography, not alone within the Newark basin itself but in the surrounding crystalline area as well. The results of this study, which are published in the Twenty-first Annual Report of the Director (part 3, pp. 1–162), have, as suspected, afforded a clue for working out the structure of the entire district by showing that the faults so clearly revealed within the Newark basin are also present (though naturally less clearly revealed) within the crystalline uplands.

My colleague, Professor H. E. Gregory, of Yale University, who has studied the area to the east of my district, soon reached the same conclusion and has expressed it in an official report to the survey upon the Farmington

quadrangle. Brief preliminary notices of the new conclusions, which were printed in the *Journal of Geology* and the *American Journal of Science*, aroused the stout opposition of the geologist in charge of geology.

After thoroughly testing the new hypothesis during several field seasons, a monograph of approximately 500 manuscript pages and numerous plates was prepared as my final report upon the structure of the district. This monograph embodies my conclusions and represents the best work of which I am capable. In submitting it I made the request, upon the basis of the novelty of certain of the conclusions reached, that the report be first read by Mr. G. K. Gilbert. I enjoyed no special personal relations with Mr. Gilbert, but placed confidence in him because of his ripe experience, great ability, and scientific temper. Mr. Gilbert kindly consented to undertake this task, and his extensive critique of the monograph, prepared after several days' study of it, while it did not accept as proven the more novel conclusions of the paper, yet was withal so fair a review and so commendatory of the way in which the report had been prepared, that I could not feel other than complimented by it. Mr. Gilbert pointed out, however, that the larger conclusions reached, if well founded, must discredit in some measure the work of other geologists both within and without the district specially studied. For this reason he recommended that the monograph be examined still more carefully by some other member of the staff of the survey, and, if possible, with the author in the field. The monograph was then referred to Mr. Bailey Willis whose report (as stated in correspondence of Mr. Hayes) recommended the publication of the monograph by the survey, but considered that the author's reputation would be better served by the omission from the monograph of certain chapters. The substance of these radical chapters has since been published in slightly abbreviated form as a bulletin of the Geological Society of America ('Lineaments of the Atlantic Border Region,' Vol. 15, 1904, pp. 483–506, pls. 45–47. Also Rept. Eighth Intern. Geographic Congress, 1904, pp. 193–203), and the letters which I have received from prominent geologists both here and abroad indicate that the opinion of this reviewer has not been an altogether general one.

The recent investigation of earthquakes has brought a wholly unexpected verification of the general correctness of the views expressed in the above paper (see my paper, entitled 'Some Principles of Seismic Geology,' with an introduction by Eduard Suess, president of the Academy of Sciences, Vienna, *Beiträge zur Geophysik*, Leipzig, Vol. 8, heft 2, 1906).

After the examination by Mr. Willis the monograph was referred by the geologist in charge of geology to Mr. George Otis Smith, who had been born in a remote corner of New England and was, therefore, presumably the one best qualified to discuss the geology of that complicated region. When placed beside the report of Mr. Gilbert, the report of Mr. Smith emphasized by its sweeping statements the latter's youth and his more recent graduation from college. The monograph had revealed to him absolutely nothing of value, unless perhaps what had already been published; and in no measured terms the methods of the author were condemned. Prompt action upon this report was taken by Mr. Hayes in refusing the publication of the monograph. At the same time an order was sent me to at once complete the manuscript and illustrations for the Litchfield folio (which covers a portion of the area), the correctness or error of which would then be adjudicated through conference in the field.

When the folio had been prepared I found that in place of a committee made up of non-partisan geologists, my work was to be judged by Messrs. Hayes and Smith, who throughout had not concealed their unfavorable opinion of the work. Messrs. A. C. Spencer and Joseph Barrell were, however, present at the conference (in April, 1905) as guests, the former upon invitation of Mr. Hayes, the latter upon my own initiative.

The Newark basin of the Pomeraug Valley having afforded the key to the structure, it was first gone over, and I believe the expressions of Messrs. Barrell, Spencer and Smith warrant me in saying that the observations of

the two days were to them a revelation of how intricate and extensive the fault system of the valley was, and how well it had been interpreted by my maps. Mr. Smith expressed the view that the faults which I had mapped were only a part of those present. Mr. Hayes merely remarked at last, 'Well, that is very convincing.' So soon, however, as the examination was transferred to the crystalline areas of the district, I found on the part of the two official reviewing authorities utter unwillingness to give any attention to the new methods which had been derived for locating faults; and in those cases where older methods were insufficient to prove the presence of the supposed fault it was assumed not to be present. The manuscript of the Litchfield folio was upon the basis of the conference accepted after emasculation, but the geologist in charge of geology would not permit the question of publication of my monograph to be reopened.

I submit to you, sir, that a geologist employed by a government bureau is entitled not only to the small pecuniary remuneration which he receives, but to the scientific fruits of his labor as well. If he is incompetent or insufficiently trained, he should be discharged; otherwise the ripe fruit of his labors for the securing of which the public money has been expended, should be made available for study. It is even possible that brother geologists may have as much interest in the opinion of the person who best knows the facts, together with the evidence upon which his conclusions are based, as in the opinion of the reviewing authorities.

The creation of the office of geologist in charge of geology by your administration has in effect introduced a public censor for all American geological work. It is to-day practically impossible to publish a large geological monograph upon any portion of the national domain without first securing the consent of the authorities of the geological survey. The United States Geological Survey has now already become responsible for a body of official dogma—largely the personal geological opinions of the geologist in charge of geology. The realization of this fact by European geologists has latterly brought the survey into some ridicule and fixed upon it the name of the 'Great American Trust,' a term by which I heard it more than once called during the past year. I maintain that such a policy is unique among geological surveys and as undemocratic as it is unscientific. So far as my knowledge extends these 'Standard Oil' methods of which I complain are not to be found in European bureaus of geology, where it is the practise to assume no responsibility for opinions expressed by staff members. Where different views have been reached by experienced workers within the same or neighboring fields, the scientific public is there given the chance to decide upon the merits of the controversy. The United States Geological Survey alone officially decides which opinion is 'right' and suppresses the others.

If we grant for the sake of argument that such an un-American policy is defensible, it is obvious that the geological censor must be a geologist not only fair minded and progressive, but of unusually wide experience and of great familiarity with the currents of geological thought in other countries. The man who holds the position of grand vizier to the head of the geological survey unfortunately possesses none of these qualifications. He is a hustling business manager of the sledge-hammer type who has transformed the survey of Powell—which in a notable manner advanced the geological thought of the world and brought golden opinions from all sorts of people—into a great mining bureau with an auxiliary map establishment for 'coloring in' the national domain. Notably ignorant of the trend of modern European geological thought—and apparently wholly oblivious to it—his stubbornness in holding an opinion once expressed has become a byword in the survey. His replies to official communications are in many instances characterized by brutal abruptness and often affect the recipient like a blow in the face. I do not consider it necessary to furnish examples, since wholly characteristic ones can be found in the published correspondence with a prominent geologist.[1]

As I shall elsewhere attempt to show, the

[1] SCIENCE, October 26, 1906.

wall of prejudice which surrounds the office of the geologist in charge of geology and makes of it a sort of national quarantine station for new ideas, is a direct and natural result of the overgrown kindergarten establishment of the survey—the department of geologic folios. The great extravagance of this enterprise almost precludes changes in the completed folios, and a ready-made pattern of geological work seems absolutely essential to its successful completion. The letters of the geologist in charge of geology in reference to new views upon areas for which folios have been published, contain expressions like, 'This folio is put forward as the final and most satisfactory results to be reached in this region,' and 'The Geological Survey can not afford to entirely reverse itself.' Should it develop that fundamental geological problems have not all been solved, it is conceivable that when the numerous map areas of the geologic atlas are tied together a century or more hence, serious difficulties will be encountered in matching borders prepared at widely different dates.

Reverting now to the conclusions which I have reached regarding the structure of southwestern New England, I may add that during the past year I have found some opportunity to note while in Europe the conclusions which are now being reached by geologists respecting other regions of crystalline rocks. In Calabria, the Vogesen, in southern Norway and especially in Scotland, essentially the same conclusions have been reached by the official geologists of those countries respecting the relative importance of fold and fault structures. I am informed by the director of the Geological Survey of Great Britain that a report will soon appear treating of the crystalline area of Scotland, within which area a definite system of faults has been found to be superimposed upon the flexures everywhere present in the district. These faults are nearly vertical, are comprised in several parallel series, and are so numerous that though the map is covered with them, a small proportion only can be represented.

I trust I have made the reasons for tendering my resignation sufficiently clear. The proper function of a great national geological survey I conceive to be something more than to report upon mining regions and to bring together some tons of geological card catalogues printed in diluted English, otherwise designated as folios. My resignation from the survey will permit me to freely express this view and raise my voice against what I consider a most pernicious influence upon American geology.

I am, sir, very respectfully,

Wm. H. Hobbs.

SPECIAL ARTICLES.

A STATISTICAL STUDY OF AMERICAN MEN OF SCIENCE: THE SELECTION OF A GROUP OF ONE THOUSAND SCIENTIFIC MEN.

The psychologist, like the student of other sciences, can view his subject from different standpoints and pursue it by various methods. He may get what knowledge he can of mental processes by introspection, or he may use objective methods. He may confine himself to the 'inner life,' or he may study the individual in all his psychophysical relations. He may give verbal descriptions, or he may make measurements. He may describe static mental life, or he may study the lower animals and human beings from a dynamic and genetic point of view. He may attempt to determine facts and laws that hold for mental life in general, or he may attend to individual differences. He may ignore the practical applications of his science, or he may investigate them. Psychology has until recently concerned itself chiefly with the first of these various alternatives. But its recent progress and future development seem to the present writer to depend particularly on the second. In this case, our two main methods, which can often be combined, are experiment and measurement in the laboratory, and the inductive and statistical study of groups of individuals. In recent years great progress has been made in both directions. Experimental psychology has become a science coordinate with the other great sciences, and statistics have been extended to include sociological and moral phenomena.

The intensive study of groups of individuals has, however, only been begun. The origin of the method may be attributed to Quetelet, whose 'Essai de physique sociale' was published in 1835, and its principal development to Dr. Francis Galton, whose 'Hereditary Genius' (1869) has been followed by a series of books and articles, including 'English Men of Science' (1874). Another work bearing closely on the subject matter of the present paper is Alphonse de Candolle's 'Histoire des sciences et des savants depuis deux siècles' (1873). Other extensive studies of groups of individuals are: Dr. Paul Jacoby's 'Etudes sur la sélection' (1881), which has as its subject matter the 3,311 Frenchmen of the eighteenth century whose biographies are included in the 'Biographie universelle,' Professor A. Odin's 'Genèse des grands hommes' (1895), which is a study of 6,382 French men of letters; Mr. Havelock Ellis's 'A Study of British Genius' (1906, published in the *Popular Science Monthly,* February–September, 1901), which considers 859 men and 43 women of eminence, and Dr. F. A. Woods's 'Mental and Moral Heredity in Royalty' (1906, published in the *Popular Science Monthly,* August, 1902–April, 1903), which treats 832 members of royal families.

I have myself selected as material for study three groups: a thousand students of Columbia University;[1] the thousand most eminent men in history;[2] a thousand American men of science.[3]

[1] 'Physical and Mental Measurements of the Students of Columbia University' (with Dr. Livingston Farrand). *Psychol. Rev.*, **3**: 618–648, 1896. Cf. also the dissertation for the doctorate of Clark Wissler 'The Correlation of Mental and Physical Tests,' *Psychol. Rev.*, Monograph Supplements, **16**: iv–62, 1901.

[2] 'A Statistical Study of Eminent Men,' *Pop. Sci. Mon.*, **53**: 359–378, 1903.

[3] 'Homo Scientificus Americanus: Address of the president of the American Society of Naturalists,' SCIENCE, N. S., **17**: 561–570, 1903. 'Statistics of American Psychologists,' *Am. Jour. of Psychol.*, **14**: 310–328, 1903. Towards the cost of computation in connection with this research, I have received a grant of two hundred dollars from the Esther Herrman Research Fund of the Scientific Alliance of New York.

Each of these groups seems to me favorable for such work. The students of Columbia College are measured, tested and observed in our laboratory; we are able to follow their academic courses and their careers in after life. The lives of the most eminent men of history are to a certain extent public property, open to statistical investigation and psychological analysis. A thousand scientific men in the United States will doubtless be willing to assist in furnishing the material needed, which is in any case accessible from other sources.

TABLE I. THE NUMBER OF AMERICAN MEN OF SCIENCE AND THEIR DISTRIBUTION AMONG THE SCIENCES.

	Special Societies.	Fellows of Association.	Members of Academy.	University Professors.	Doctorates in Five Years.	Contributors to SCIENCE 13 Vols.	Who's Who.	Biographical Dictionary (Estimated).[4]
Mathematics..	375	81	1	136	61	35	46	380
Physics	149	167	23	105	69	155	73	556
Chemistry.....	1933	174	12	143	137	73	166	656
Astronomy ...	125	40	12	41	16	48	51	212
Geology.....	256	121	13	55	32	161	174	436
Botany.....	169	120	7	57	53	94	70	416
Zoology.....	237	146	17	83	72	243	131	620
Physiology ...	96	10	2	53	18	22	25	156
Anatomy.....	136	10	0	56	1	13	18	116
Pathology.....	138	14	5	68	4	44	56	224
Anthropology	60	60	3	4	5	56	37	92
Psychology ...	127	40	1	37	63	58	21	136
Total.....	3801	983	96	838	531	1002	868	4000

REDUCED TO PER THOUSAND.

Mathematics..	99	32	10	162	113	35	53	95
Physics.....	39	170	240	125	128	155	84	139
Chemistry.....	506	177	125	171	265	73	191	164
Astronomy...	33	41	125	49	30	47	59	53
Geology.....	68	123	136	66	60	161	200	109
Botany.....	45	122	73	68	99	94	81	104
Zoology.....	63	149	177	99	134	243	151	155
Physiology ...	25	10	21	63	34	22	29	39
Anatomy	36	10	0	67	2	13	21	29
Pathology.....	36	14	52	81	8	44	64	56
Anthropology	16	61	31	5	9	56	43	23
Psychology ...	34	41	10	44	118	57	24	34

[4] The distribution among the sciences of those in the 'Biographical Directory of American Men of Science' (published this year by The Science Press, New York) differs rather more than I had expected from this estimate, which was based on the first thousand entries that were written.

The accompanying table, which with most of the data to be discussed refers approximately to January 1, 1903, shows how American men of science are distributed among the principal sciences by various agencies. There are in the table certain facts that require allowance, or at least mention. The American Chemical Society and the doctorates conferred in chemistry represent in part professional work in applied science. Under the special societies there are duplications, as scientific men may belong to more than one society. The American Mathematical Society and the Association of American Anatomists have been rather liberal in the admission of members. As mathematics and the medical sciences are required subjects for large groups of students, there are many teachers, but this has not produced a proportional number of investigators. The membership of the National Academy represents to a certain extent the interests of the passing scientific generation, the doctorates the interests of the coming scientific generation.

In selecting a group of a thousand scientific men, the number in each science was taken roughly proportional to the total number of investigators in that science, the numbers being: Chemistry, 175; physics, 150; zoology, 150; botany, 100; geology, 100; mathematics, 80; pathology, 60; astronomy, 50; psychology, 50; physiology, 40; anatomy, 25; anthropology, 20.

There are in the 'Directory' 4,131 names, of whom 131 are students of philosophy, education, economics and sociology, leaving just 4,000 in the twelve sciences under consideration. They are distributed among the sciences as follows: mathematics, 340; physics, 672; chemistry, 677; astronomy, 160; geology, 444; botany, 401; zoology, 441; physiology, 105; anatomy, 118; pathology, 357; anthropology, 91; psychology, 194. These figures were not at hand when it was necessary to select the thousand men of science for this research. The numbers under physics and pathology are increased by the inclusion under these sciences of engineers and physicians. The chief discrepancy is that there are fewer zoologists than was indicated by the preliminary estimate or by the other data of the table.

The individuals were selected by asking ten leading representatives of each science to arrange the students of that science in the order of merit. There were for each science slips made with the names and addresses of all those known to have carried on research work of any consequence. The total number assigned a position was 2,481, distributed among the sciences as follows: Mathematics, 201; physics, 261; chemistry, 389; astronomy, 165; geology, 257; botany, 213; zoology, 290; physiology, 101; anatomy, 89; pathology, 251; anthropology, 72; psychology, 192. These numbers included duplications when a man was given a place in more than one science.

The memorandum sent to those who were asked to make the arrangement was as follows:

MEMORANDUM.

The undersigned is making a study of American men of science. The first problem to be considered is the distribution of scientific men among the sciences and in different regions, institutions, etc., including the relative rank of this country as compared with other countries in the different sciences, the relative strength of different universities, etc. It is intended that the study shall be continued beyond the facts of distribution to what may be called the natural history of scientific men.

For these purposes a list of scientific men in each science, arranged approximately in the order of merit, is needed. This can best be secured if those who are most competent to form an opinion will independently make the arrangement. The average of such arrangements will give the most valid order, and the degree of validity will be indicated by the variation or probable error of position for each individual.

It is obvious that such an order can be only approximate, and for the objects in view an approximation is all that is needed. The judgments are possible, because they are as a matter of fact made in elections to a society of limited membership, in filling chairs at a university, etc. By merit is understood contributions to the advancement of science, primarily by research, but teaching, administration, editing, the compilation of text-books, etc., should be considered. The different factors that make a man efficient in advancing science must be roughly balanced. An effort may be made later to disentangle these factors.

In ranking a man in a given science his contributions to that science only should be considered. Thus, an eminent astronomer may also be a mathematician, but in ranking him as a mathematician only his contributions to mathematics should be regarded. In such a case, however, mathematics should be given its widest interpretation. It is more difficult to arrange the order when the work can not readily be compared, as, for example, systematic zoology and morphology, but, as already stated, it is only expected that the arrangement shall be approximate. The men should be ranked for work actually accomplished, that is, a man of sixty and a man of forty, having done about the same amount of work, should come near together, though the man of forty has more promise. It may be possible later to calculate a man's value with allowance for age.

In case there is noted the omission of any scientific man from the list who should probably have a place in the first three quarters, a slip may be added in the proper place with his name and address. In case there are names on the list regarding which nothing is known, the slips should be placed together at the end. The slips, as arranged in order, should be tied together and returned to the undersigned.

It is not intended that the lists shall be published, at all events not within ten years. No individual list will be published. They will be destroyed when the averages have been calculated, and the arrangements will be regarded as strictly confidential.

The ten positions assigned to each man were averaged, and the average deviations of the judgments were calculated. This gave the most probable order of merit for the students in each science, together with data for the probable error of the position of each individual. The students of the different sciences were then combined in one list by interpolation, the probable errors being adjusted accordingly. The list contains 1,443 names, of whom the first thousand are the material used in this research.

It should be distinctly noted that the figures give only what they profess to give, namely, the resultant opinion of ten competent judges. They show the reputation of the men among experts, but not necessarily their ability or performance. Constant errors, such as may arise from a man's being better or less known than he deserves, are not eliminated. There is, however, no other criterion of a man's work than the estimation in which it is held by those most competent to judge. The posthumous reputation of a great man may be more correct than contemporary opinion, but very few of those in this list of scientific men will be given posthumous consideration. I am somewhat sceptical as to merit not represented by performance, or as to performance unrecognized by the best contemporary judgment. There are doubtless individual exceptions, but, by and large, men do what they are able to do and find their proper level in the estimation of their colleagues.

In order to obtain the 10 arrangements in each science, or 120 in all, it was necessary to ask the assistance of 192 scientific men. Twenty-three of these did not reply to my letter; 16 declined to make the arrangement, usually on the ground that it was not feasible; 23 consented, but afterwards gave it up or did not send the slips in time, and 10 made arrangements that could not be used, in most cases because the names were arranged in groups instead of being ordered serially. As the arrangement resulted, those who made it and those who were asked but failed were distributed in the different hundreds of the thousand, as follows:

TABLE II. THE STANDING OF THOSE WHO MADE THE ARRANGEMENTS AND OF THOSE WHO WERE ASKED BUT FAILED.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	Total.
Observers..	47	26	20	9	6	3	1	1	3	4	0	120
Failed.....	29	20	10	5	1	0	3	1	0	1	2	72
Total.....	76	46	30	14	7	3	4	2	3	5	2	192

Thus 76 of those who proved to be in the first hundred men of science were asked to make the arrangement and 47 of them did so. Only twelve of those who made the arrangement are not in the first five hundred. In anthropology, for example, there are only twenty representatives in the list, of whom but two would probably be in the first hundred, and of the twelve sciences there are only

three that would be expected to have more than ten in the first hundred. It is, therefore, evident that the ten scientific men who gave the judgments in each science are among the leaders in that science. But their standing must of necessity vary with the different sciences, one half of all the anthropologists having made the arrangement and only two thirty-fifths of all the chemists.

Those asked to arrange the names were distributed among different institutions, as shown in Table III.

TABLE III. THE DISTRIBUTION AMONG INSTITUTIONS OF THOSE WHO WERE ASKED TO MAKE THE ARRANGEMENTS.

	Number in 1,000.	Number Asked.	Per Cent. Asked.	Number of Observers.	Per Cent. of Observers.	Per Cent. of Those Asked.
Harvard	66.5	23	.35	7	.10	.30
Columbia	60.0	20	.33	13	.21	.65
Chicago	39.0	17	.44	15	.38	.88
Cornell	33.5	6	.18	4	.12	.67
Geological Survey	32.0	7	.22	4	.12	.57
Depart. of Agriculture	32.0	3	.09	3	.09	1.00
Hopkins	30.5	13	.43	5	.16	.38
Yale	26.5	8	.30	6	.23	.75
Smithsonian Institution	22.0	9	.41	5	.23	.55
Michigan	20.0	9	.45	7	.35	.78
Wisconsin	18.0	3	.17	2	.11	.67
Pennsylvania	17.0	10	.59	6	.35	.60
Stanford	16.0	3	.19	3	.19	1.00
Princeton	14.5	3	.21	0	0	0
New York University	9.5	5	.53	4	.42	.80
Clark	7.0	5	.71	3	.43	.60
New York Bot. Garden	6.0	2	.33	2	.33	1.00
One at each institution		46	.08	31	.06	.67
Total		192		120		

Thus 23 scientific men connected with Harvard University were requested to sort out the slips; this was done by 7 of them. Sixty-six and five tenths of the thousand, as the list resulted, are at Harvard University; about 10 per cent. of them made the arrangement, which is about 30 per cent. of those asked. Seventeen of the 39 scientific men at the University of Chicago were asked to make the arrangement, of whom fifteen accomplished it and two did not. Or 38 per cent. of all its men made the arrangement, who were 88 per cent. of those asked. The numbers are in most cases too few to give a correct measure of the cooperativeness in such a scheme of the different institutions, but, so far as they go, they are not altogether without interest. They are not, however, printed here for that purpose, but in order to show the geographical distribution of those who made the arrangement. It appears that different institutions are fairly well represented, there being no great preponderance of any one of them. Of the 120 who made the arrangement 89 are connected with the 17 institutions given in the table, although these institutions contain only 450 of the 1,000 scientific men. They, however, have, as will be shown later, a much larger proportion of the more eminent scientific men.

Those who made the arrangements are not likely to possess equal information, impartiality and good judgment. If there were only two arrangements of each group it would not be possible to decide objectively which is the better. We have, however, ten arrangements, and the average is more likely to be correct than any one of them. The conditions are the same as in the case of observations in the physical sciences. As the personal equation of the astronomer is determined by comparing his observations with those of other astronomers, so here we can measure the accuracy of judgment of each observer by determining how far it departs from the average judgment.

I have counted up the departures of each of the ten observers from the average result for one of the groups, namely, the fifty psychologists. The data are given in Table IV. by groups of ten.

The observer A is always more accurate than any other observer, except in one case in the fifty. The validity of judgment of the ten observers varies from 7.9 to 17.26, or about as 1:2, which is approximately the variability that I have found in normal individuals in other mental traits, such as accuracy of perception, time of mental processes, memory, etc. The departures from the mean reliability of judgment, given in the last line of the table, indicate that accuracy of judgment tends in a general way to follow the normal distribution of the probability curve, though with so few cases this may be accidental. As the

TABLE IV. MEASUREMENTS OF THE ACCURACY OF JUDGMENT OF TEN OBSERVERS.

	A	B	C	D	E	F	G	H	I	J	Average.
I.	1.6	5.2	2.3	3.1	1.9	2.8	1.8	2.4	5.0	2.6	**2.87**
II.	4.9	7.0	8.7	7.8	6.3	4.2	10.2	6.1	7.0	5.1	**6.73**
III.	7.1	11.1	13.5	12.4	24.2	16.2	12.5	12.0	16.9	27.6	**15.85**
IV.	13.8	18.0	16.7	18.4	18.8	18.1	22.7	25.4	21.9	25.5	**19.96**
V.	12.1	17.4	21.1	21.1	13.2	26.6	21.7	24.7	22.9	25.5	**20.63**
Av.	**7.9**	**11.74**	**12.46**	**12.56**	**12.88**	**13.58**	**13.78**	**14.12**	**14.74**	**17.26**	**13.1**
A.	*—5.20*	*—1.36*	*—0.64*	*—0.54*	*—0.2 5*	*+0.48*	*+0.68*	*+1.02*	*+1.64*	*+4.16*	*±1.60*

validity of the judgments varies to a measured degree, the arrangements made by the individuals could be weighted. I have not undertaken the somewhat tedious calculations necessary; they would not considerably alter the order, but would make it somewhat more exact, at the same time decreasing the probable errors.

There is here measured for the first time, I think, the accuracy or reliability of judgment. This is obviously a complex and imperfectly analyzed trait, depending on a large number of varying conditions. A man's judgment may be good in some directions or from certain points of view, and bad in other ways. Still we understand vaguely what is meant by good judgment and value the trait highly in ourselves and in others. Thus most people complain that they have a bad memory, but I have never heard any one acknowledge that he had a bad judgment. It appears that the measurement of the reliability of judgment of individuals may have wide-reaching applications in civil service examinations and in all cases where individuals are selected for special purposes, a balanced judgment being nearly always more important than the kind of information that can be tested by a written examination. I have measured the accuracy of observation and memory[5] and Dr. F. B. Sumner has measured the validity of beliefs.[6] When we learn to look upon our observations, recollections, beliefs and judgments objectively, stating in numbers the probability of their correctness and assigning probable errors to them, there will be an extraordinary change in our attitude in religion, politics, business and all the affairs of life.

There are two cases in which these judgments were subject to special conditions which it may be worth the while to notice—that in which a man of science gave his own position and that in which he gave the positions of his immediate colleagues. In sending out the slips, nothing was said as to whether it was expected that a man should include his own name. Of the 120 who made the arrangement, 34 gave positions to themselves; 20 assigned positions to themselves lower than that resulting from the average judgment, twelve higher positions and two the same positions. On the other hand, 22 gave themselves positions higher than the average grade (which is lower than the position, being related to it somewhat as the average is to the median), ten lower and two the same. The judgments were somewhat more accurate than the average judgments. In 21 cases the departures from the mean were less than the average departures and in 13 cases they were larger. It thus appears that there is on the average no constant error in judging ourselves—we are about as likely to overestimate as to underestimate ourselves, and we can judge ourselves slightly more accurately than we are likely to be judged by one of our colleagues. We can only know ourselves from the reflected opinions of others, but it seems that we are able to estimate these more correctly than can those who are less interested. There are, however, wide individual differences; several observers overestimate themselves decidedly, while others underestimate themselves to an equal degree.

[5] 'Measurements of the Accuracy of Recollection,' SCIENCE, N. S., **2**: 761–6, 1895.

[6] 'A Statistical Study of Belief,' *Psychol. Rev.*, **5**: 616–31, 1898.

We tend to overestimate the positions of our immediate colleagues, though the departure from the average judgment is not considerable. Here again there are decided individual differences; thus one man assigned positions to six of his colleagues, all of which were above the average, and another assigned positions to five of his colleagues, all of which were below the average. Most of us also overestimate those whose lines of research are similar to our own.

These factors affect the order of the names in the list but slightly, though they increase the probable errors. A more considerable variation is due to the fact that the names were divided among twelve sciences, whereas the lines between the sciences are artificial. A man's work may not fall naturally in one of these conventional sciences, or it may fall in two or more of them. In such cases he is likely to receive a lower position than he deserves. It is not clear how this difficulty could have been avoided, for if more departments of science had been used, the overlapping would have been greater.

TABLE V. THE NUMBERS OF THOSE WHO WERE ASSIGNED A POSITION IN MORE THAN ONE SCIENCE.

	Mathematics.	Physics.	Chemistry.	Astronomy.	Geology.	Botany.	Zoology.	Physiology.	Anatomy.	Pathology.	Anthropology.	Psychology.	
Mathematics ...	—	1		3	1							1	6
Physics	11	—	1	4	1								17
Chemistry		3	—		3			2		1			9
Astronomy.....	9			—									9
Geology				1	—	1	2		2				6
Botany			1		2	—				1			4
Zoology					4		—	3	15	1			23
Physiology... ..			2					—	1	4		2	9
Anatomy.....							4	3	—	1		1	9
Pathology			3					2	1	—			6
Anthropology..					1				4		—	1	6
Psychology								1			1	—	2
	20	4	7	8	12	1	6	11	23	8	1	5	106

Table V. gives the cases in which the thousand scientific men were given places in the lists of two or more sciences, even though in the science in which they were given the lower position they did not come within the thousand, but only in the 1,443 who made up the total list. The horizontal lines of the table give those who were assigned the higher position in the science named, and the vertical lines those who were assigned the lower position. Thus there was one man whose higher position was in mathematics, but who was also given a position in physics, and there were eleven men who are primarily physicists and secondarily mathematicians. There are 93 men who have a position in two sciences, five who have a position in three sciences and one who has a position in four sciences. It thus appears that about one tenth of our scientific men do work of some importance in more than one of the twelve sciences here defined.

The chief interest of the table is that it gives a certain measure of the relationships of the sciences. Thus mathematics, physics and astronomy, on the one hand, and zoology, anatomy and physiology, on the other, are the most closely interrelated groups. This might have been foreseen, but the table gives the definite relations. There are but few who are anatomists only, whereas botany is the science which is the least likely to be combined with any other. One of the most serious obstacles to the advancement of science is the lack of men who are expert both in an exact and in a natural or biological science.

There are in all the leading countries academies of science, whose membership is supposed to consist of their most eminent scientific men, and one of the principal functions of such academies appears to be the election of members as an honor. The methods of selection used in this research are more accurate than those of any academy of sciences, and it might seem that the publication of the list would be as legitimate as that of a list of our most eminent men selected by less adequate methods. But perhaps its very accuracy would give it a certain brutality.

Of the first hundred scientific men on the list who are eligible, 61 are included among the 97 members of the National Academy of Sciences, and of the first 30 men on the list 28 are members of the academy. The elections to the academy tend to follow the list pretty closely in the order in which men are arranged

in the separate sciences—usually falling within the probable error of position. But the academy has no method of comparing performance in different sciences, and if one science has less than its proper representation, the disparity is likely to increase rather than to decrease. Thus there are in the country about half as many astronomers as botanists, but there are twice as many astronomers in the academy. The second principal variation in the membership of the academy is due to the fact that men do not always retain the positions that they hold when elected. Apart from the somewhat greater accuracy, the superiority of this list consists in the assignment of probable errors of position. Thus the probable error at the close of the first hundred is about 25 places, that is, there are about 25 men not in an ideal academy of a hundred, whose chances of belonging there are at least one in four. A list such as this would also give us academies of any desired size—the sixty most eminent men of science, as in the Paris Academy, the hundred or thereabouts as in the National Academy, or the 450 or thereabouts, as in the Royal Society.

While under existing conditions of sentiment, the publication of a list of our thousand leading men of science in the order of merit with the probable errors would not be tolerated, I have indicated those who are included in the thousand in my 'Biographical Directory of American Men of Science,' a work of reference that may be regarded as a by-product of this study. I did this with some hesitation, but it seemed best to place on record those who were the subjects of this research, more especially as this could be done without any invidiousness. The probable error toward the end of the list is about 100 places, so there are one hundred others who have at least one chance in four of belonging to this group. Further, several scientific men of standing were omitted from the lists as originally drawn up, and were not considered in making the arrangements. Consequently, while each of those indicated in the Biographical Directory is probably one of the leading thousand American men of science, there are others not indicated who belong to this group. This, however, is a minor factor, and we have with sufficient accuracy for statistical purposes a group of the leading thousand American men of science arranged in the order of merit with the probable errors of position known.

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A NOTE ON ASSORTATIVE MATING.

IN the natural selection and topographic isolation theories combined there is offered a plausible explanation of the means whereby species may be derived from other species, granted that the derived species do not occupy the same geographic (topographic) range as the parent form. Where they do, some new aid to natural selection in place of topographic isolation must be invoked to explain how slight variation may be progressively increased until differences of selective worth exist between parent and splitting-off types. Determinate variation and physiological isolation are two such aids proposed. The latter (with which Romanes's name is familiarly associated) assumes that among the members of a species living in the same locality there may be among the inevitable slight fluctuating variations some of such a character as to lead to assortative mating, *i. e.*, that individuals of certain like variation may tend to mate together, either because of mutual attraction between like, or of mutual repulsion between unlike forms. This tendency to selective or assortative mating between like individuals may come to result in time in such an increase of differentiation among groups of individuals of the species, although these groups may live side by side or confusedly mingled with each other in the same locality, that mating between unlike groups will become physiologically impossible. That is, that these groups will constitute distinct species.

The facts of observation or experiment adduced to support this theory are very few. Indeed, I do not recall any at the present moment. Nevertheless, the need of an aid to selection capable of bringing slight continuous fluctuating variation up to a life-and-death selective value, and the generally plausible character of this theory of Romanes (and of

other earlier evolutionists) has given it a certain standing in the literature of bionomics.

A student in my laboratory, Miss Lilian Ramsay, in a general study of variation and heredity in certain insects, has been able to gather some definite data in regard to assortative mating (the basic assumption of the physiological isolation theory) in the case of an insect species common on our university campus. Unfortunately the earthquake of last April interrupted her interesting observations. Her data are the following:

The lady-bird beetle, *Hippodamia convergens*, is an insect of much variability as to its dorsal color pattern (dorsal surfaces of the two wing-covers). The modal type shows a red-brown ground bearing twelve small black spots (six on each wing-cover). The variation in additions to or subtractions from these normal twelve spots, and in their arrangement, is so large, extending from a condition of total absence of spots to that of the presence of eighteen distinct spots, that we have been able to describe, in words, some eighty-four 'aberrations' or pattern[1] types of this species. As any of these variations may appear in conjunction with any others in a single brood (one clutch of eggs), it is certain that these aberrations are all included within the species. Is there now any assortative mating among these variations?

In March and April Miss Ramsay found the beetles mating on the wild mustard on which their food, the mustard aphis, swarms. Collecting these actually mating couples, she brought them into the laboratory, noted the pattern types to see if assortative mating on a basis of pattern—this being largely the basis for specific separation in the genus—was occurring, then put each couple into a breeding jar to obtain the eggs and rear the young, to ascertain if the various matings were similarly fertile. The earthquake interrupted the collecting and made impossible the determination of fertility. The actual matings of sixty couples as they occurred normally in nature were as follows:

Thirty cases of twelve-spotted *Hippodamia convergens* with twelve-spotted *H. convergens*.

Thirteen cases of twelve-spotted *H. convergens* with spotless *H. convergens*.

Five cases of spotless *H. convergens* with spotless *H. convergens*.

Two cases of twelve-spotted *H. convergens* with two-spotted *H. convergens*.

Two cases of one-spotted *H. convergens* with spotless *H. convergens*.

One case of twelve-spotted *H. convergens* with ten-spotted *H. convergens*.

One case of two-spotted *H. convergens* with spotless *H. convergens*.

One case of spotless *H. convergens* (female) with *Megilla vittigera* (male), a distinct species with three strong, longitudinal stripes instead of spots.

Also there were noted seven cases of the mating of plain *Coccinella californica* with plain *C. californica*, and one case of plain *C. californica* with two-spotted *C. californica*. *Coccinella californica* also frequently mates with *Hippodamia convergens*, as we have observed at various times.

As regards relative abundance of the various variation types of *Hippodamia* and *Coccinella*, the twelve-spotted and the spotless *Hippodamia* individuals far outnumbered any other types and the spotless *Coccinellas* were much more numerous than spotted ones.

The matings, therefore, seem obviously to be wholly non-selective; they are chance matings, that is, follow the law of probability. All the individuals, spotless, twelve-spot and few-spot, mingle freely on the same mustard plant, so that the matings might readily be assortative. If not assortative, then the relative proportion of numbers of the different types should determine the matings. And this is what apparently really obtains.

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[1] See Kellogg and Bell, 'Studies of Variation in Insects,' *Proc. Wash. Acad. Sci.*, Vol. 6, pp. 203–332, 1904, for a detailed account of the variation of the species.

THE SALARIES OF PROFESSORS.[1]

Despite the heavy burdens upon the cor-

[1] From the report of President Butler, of Columbia University.

poration as referred to at length in another part of this report, it is not possible longer to avoid facing the fact that the salaries paid to the professors and adjunct professors of the university are inadequate, and that the effects of this inadequacy are deplorable.

So long ago as 1857, the trustees gave serious consideration, at the hands of a special committee, to the subject of the compensation which should properly be paid to the professors in Columbia College.

On May 11, 1857, it was

Resolved, That the incumbents of the chairs of chemistry, of mathematics, of moral and intellectual philosophy, of ancient and modern literature and of history and political economy, should severally receive a salary at the rate of $3,000 per annum.

At the same time it was provided that in addition to such salary there should be allowed to those professors to whom a dwelling was not assigned at the college, a sum not exceeding $1,000 per annum for house rent. In the course of a few years this provision resulted in making the salaries of the incumbents of the chairs named $4,000 each.

In 1861 it became necessary to reduce the expenses of the corporation, and in that year a substantial reduction was made in the amount of the salaries paid to the several professors. Those professors who had been in receipt of an annual salary of $4,000 each had their compensation reduced to $3,600 each, and one professor who had been in receipt of a salary of $3,300 had his compensation reduced to $2,900.

At the time when this reduction in compensation was made there were, in addition to the president, but ten professors in the service of the college.

On February 5, 1866, a select committee of five, which had been appointed to consider and report upon the amount of salaries and compensation received by the several members of the faculty, and to consider and report whether it was expedient or proper to make any changes in the rate of compensation allowed to any or all of the professors, and whether it was expedient or proper to discriminate between the several professors as to their salaries or rate of compensation, and if so, as to how such discrimination should be made, submitted an elaborate report.

It appeared that at the date of the report there were, in addition to the president, seven professors in active service in Columbia College. Of these, five received salaries of $4,000 each, one a salary of $3,300 together with the free occupancy of a house, the rental of which was estimated at $700, and one a salary of $1,800. The professor of municipal law received a salary of $6,000 and a proportion of the tuition fees of the students of law, which for the year covered by the report had increased his salary to $7,607.64. The professor of political science received a salary of $4,000, and the three professors in the newly established School of Mines received salaries of $3,000 each.

The special committee made inquiry as to the salaries paid at other institutions of learning, and reported that at Union College the stated salary of a professor was $1,500, to which had been added for each of the two years past an increase of 20 per cent., or $300. The usual salary of a professor at Yale College was $2,300, and at Harvard College, $2,400. The committee pointed out that the three institutions mentioned were all situated in places where the expenses of living were less than in the city of New York, and that this difference should be borne in mind in estimating the value of the salaries received by the professors in the several institutions.

The committee also stated that, inasmuch as Columbia College was chiefly dependent upon private liberality for support and had but slender means of its own, the compensation then paid to its professors was inadequate as a result of necessity and not from choice, and that, therefore, no proper conclusion could be drawn as to what the salary of a professor should be from the amount then paid.

After reviewing all the information at their command, the special committee expressed the opinion that the salaries paid to the professors of Columbia College were adequate at the time they were established, but that the time had come when they should be changed. The

committee expressed a willingness to discriminate in regard to the compensation to be paid to the several professors, and suggested that the only proper basis of discrimination was to be found in the amount of service rendered by each. The committee admitted the difficulty, and perhaps the impracticability, of running an even line of justice in making such discriminations, but were prepared to accept usage as throwing some light upon the discriminations which might wisely be authorized.

It is interesting to observe that then as now the professors were confronted by problems due to the greatly increased cost of living. In the belief, apparently, that this increased cost was the result of the civil war and would not continue, the committee recommended that all salaries be increased by twenty-five per cent. for each of two years. The effect of these recommendations was to fix the salaries of the chief chairs in the college at $4,000, and to make an additional grant of $1,000 each to the incumbents of such chairs for each of two years. Subsequently, on several occasions, the trustees made a temporary augmentation in the salary of the professors, with the result that at one time the incumbents of the leading chairs were in receipt of a compensation of $6,000.

This was the situation when, on December 6, 1875, the trustees received a communication signed by each of the eight professors then in active service in the college, from which the following quotation may be made:

> In the year 1857 the trustees of the college established a rate of compensation for the professors, which they deemed just and no more than adequate.
>
> In consequence of the greatly increased cost of living produced by the war of the rebellion and other causes, the trustees increased the compensation of their professors—but the experience of our body has made us feel keenly that the increase in the cost of living has been greater than that of the compensation. The professors were in better condition seventeen years ago than they are now, when the college has so much ampler means.
>
> Not only do we find it impossible to save anything from our salaries for future needs or for our families, but we are unable to meet our necessary expenditures without drawing upon other resources or seeking uncongenial and inappropriate employment. We believe that the true interests of our college require that the compensation of its professors should be such as to free them from the necessity of extraneous work merely for pay. Feeling severely the annually increasing pressure of narrowed means, and the distracting influence of the ever-recurring difficulty of providing for our household necessities, we respectfully present this statement to your honorable board, and request that you will give it a generous consideration.

The communication was referred to a special committee of five members of the board, consisting of Mr. Rutherfurd, Mr. Nash, Mr. Schermerhorn, Mr. Harper and Mr. Beekman.

On February 7, 1876, this committee presented a careful report in which it was stated that the committee's recommendations were governed by the following considerations:

1. That the chairs of our principal academic professors should be looked upon as dignified and most desirable positions, capable of commanding the services and satisfying the reasonable ambition of the highest grade of talent and most extensive acquirement, and that to this end these professors should be placed upon a social and pecuniary equality with at least the average of successful professional men and freed from the grinding cares incident to a struggle to reconcile the demands of a conspicuous and responsible position with the necessities of insufficent means.

2. Your committee are satisfied that in the city of New York, with its high rents, high prices, and countless social demands, a yearly salary of $6,000 is inadequate to place the professors in the position it is desirable they should occupy.

3. Your committee think that it would be unwise to remove the statutory restrictions which now prevent an academic professor from engaging in any professional or other pursuit. They are also of opinion that it is a wise discrimination which has not applied any such restriction to the professors of the Schools of Mines and of Law. No such restrictions exist, so far as your committee have been able to learn, in the academic department of any other American college, in most of which the professors engage in outside work and in many cases hold professorships in other institutions; but this undesirable condition is

chiefly due to the inability of the colleges to pay adequate salaries.

The committee thereupon recommended that the salaries of the professors of Greek, chemistry, mathematics and astronomy, moral and intellectual philosophy, mathematics, mechanics and physics and Latin be fixed at $7,500 each.

This report was accepted and its recommendations were adopted. This very satisfactory scale of compensation for professors was not, however, maintained for more than a few years. One or two new chairs were established and their incumbents compensated at this rate. About this time, however, began the rapid expansion of the college into a university, and the resources of the corporation were far from sufficient to permit the payment of this compensation to the large number of new professors who were from time to time appointed.

As a consequence, while the maximum salary paid to a professor in the university has not been altered since the action of the trustees in 1876, it is a long time since any appointments have been made at that maximum compensation. The budget for 1906–7 shows that there are 119 professors and 39 adjunct professors in the service of the university at the present time, excluding clinical professors and those upon the Barnard College and Teachers College foundations. Of these, 111 professors and all 39 adjunct professors are in receipt of compensation. The average salary paid to the 111 professors in receipt of compensation is $3,746.85, and the average salary paid to the 39 adjunct professors is $2,126.92. It will be seen, therefore, that the average salary paid to a Columbia University professor in 1906 is almost exactly one half of the sum named by the trustees in 1876 as necessary to enable him to maintain his proper position in the community.

Serious as this comparison appears at first glance, a consideration of all the attendant circumstances will make it more serious still. If the professors of 1876 were able to make successful appeal for an increase of compensation because of the increased cost of living as compared with 1857, what shall be said of the professors of 1906, who have to meet a cost of living increased far beyond the standard which prevailed in 1876?

It is possible, by reference to undisputed authority, to show with some precision what changes have occurred during the past thirty years in the price of those articles which enter most largely into the cost of living.

From 1860 to 1873 wholesale and retail prices in the United States, expressed in terms of the gold dollar, rose irregularly until in the latter year they were substantially 27 per cent. higher than in 1860. This conclusion was reached in the 'Senate Report on Wholesale Prices' in 1891 (Part I., page 99) and is substantially confirmed by the index numbers made use of by the London *Economist* and by the computations made by Sauerbeck, the high German authority. Professor Mayo-Smith in a careful critical article on 'Movements of Prices,' which appeared in the *Political Science Quarterly* for September, 1898, accepted as substantially conclusive the general agreement of Sauerbeck, the *Economist* and the senate report, so far as these early figures are concerned.

The senate report in question was devoted chiefly, however, to the fall of prices alleged to have occurred from 1873 to 1891. Many statisticians hold that the senate report, because of the particular articles selected by it for price quotation, greatly exaggerated the decline of prices between 1873 and 1891. Professor Mayo-Smith regarded the figures of Sauerbeck and the *Economist* as the more trustworthy for the later period. After summarizing Sauerbeck's index numbers from 1879 to 1898, Professor Mayo-Smith reached this conclusion:

> It will be observed that this table is based entirely upon the wholesale prices of foods and raw materials. The total index number shows that since the period 1866 to 1877 there has been a fall of 36 per cent. in average prices. The fall has been greatest in textiles; the next heaviest fall has been in sugar, coffee and tea; the least fall has been in animal food. In most cases the fall seems to have reached its lowest point about 1896. (*Statistics and Economics*, p. 203.)

Analyzing groups of commodities used in

the senate report, Professor Mayo-Smith points out the important fact that it was not in the real necessaries of life that the fall occurred from 1873 to 1896. He says:

> But the different groups behave in a very extraordinary way. Food is at about the same level as in 1860, while lumber and building materials have actually increased 22 per cent. The manufactured articles, such as cloths and clothing and house-furnishing goods show a very great decrease. (*Ibid.*, p. 205.)

While, therefore, the cost of living was, on the whole, lower in 1896 than in 1876, the decrease appears to have been in the conveniences and comforts rather than in the immediate necessaries of life.

For the years 1897 to the present time, we are so fortunate as to have a very careful and trustworthy record of prices compiled by the department of commerce and labor, and published in the *Bulletin of the Bureau of Labor*, No. 63, March, 1906. This report shows that a rapid and continuous advance of prices has gone on since 1896. Summarizing the prices quoted the *Bulletin* says:

> Wholesale prices, considering all commodities, reached a higher point in 1905 than at any other time during the sixteen years covered by this investigation. * * * The 1905 average, compared with the year of lowest average prices during the sixteen years from 1890 to 1905, in each of the general groups of commodities, shows farm products 58.6 per cent. higher than in 1896; food, etc., 29.7 per cent. higher than in 1896; cloths and clothing 22.9 per cent. higher than in 1897; fuel and lighting 39.4 per cent. higher than in 1894; metals and implements 41.8 per cent. higher than in 1898; lumber and building materials 41.4 per cent. higher than in 1897; drugs and chemicals 24.1 per cent. higher than in 1895; house-furnishing goods 21.5 per cent. higher than in 1897; and the articles included in the miscellaneous group 23.4 per cent. higher than in 1896. (P. 338.)

A comparison of these authoritative statements appears to justify the following conclusions:

That the rise of prices since 1896 has considerably more than offset the fall from 1873 to 1896; that there has been an advance of at least 10 per cent. beyond the level of prices that prevailed in 1876, and that the prices of such fundamental necessaries of life as farm products and building materials are probably at least 50 per cent. higher than they were in 1876, at which date they were, according to the senate report (Part I., p. 99), at least 10 per cent. higher than they had been in 1860. Specifically food was 9.1 per cent. higher and building materials 21.7 per cent. higher.

The important facts, then, are: (1) That the present average salary paid to a Columbia University professor is but one half of the sum fixed as necessary thirty years ago; and (2) that the cost of living has meanwhile increased between 10 and 20 per cent. The purchasing power of the average salary of 1906 is, therefore, hardly more than 40 per cent. of the purchasing power of the salary established in 1876. In other words, the great and noteworthy expansion of the university, which has been brought about by the labors of the university teachers, has also been brought about at their expense.

Perhaps no class in the entire community has suffered more from the rise in the cost of living than the college and university teachers. A recent publication by the department of commerce and labor indicates that the wages of manual laborers are increasing just now faster than the cost of living; but with the college and university teacher the reverse is the case.

The most important need to this university at the present time is an addition to the endowment fund sufficient to enable the establishment and maintenance of a proper standard of compensation to members of the teaching staff. When the action of 1876 was taken, there were but seven professors to be affected by it. A very small sum of money sufficed then to make a very substantial addition to the salary of each. Now there are 119 professors and 39 adjunct professors, 158 in all. To increase the salary of each by only one thousand dollars on an average—not at all an adequate amount—would absorb the interest at 5 per cent. on a capital sum of more than three million dollars. Nevertheless, this great sum must be obtained and these compensations must be fixed and paid

or we cannot hope to attract and keep the best men in the teaching profession, nor can we enable those already in it to represent the intellectual and moral interests of the community as those interests should be represented. A capital sum of five million dollars, yielding 4½ per cent. per annum, is required at the present time to establish a proper rate of compensation for the teaching staff of Columbia University, without adding a single new instructor to that staff. This need is so imperative and the public interests affected by it are so large and so important, that the mere statement of it ought to bring us the needed sum, great though it is, from the men and women who are the large-minded possessors of wealth in this community.

SCIENTIFIC NOTES AND NEWS.

THE Nobel prize in medicine for 1906 will be divided between Professor Camillo Golgi (Pavia) and Professor Ramon y Cajal (Madrid).

THE Royal Society's medals have this year been adjudicated by the president and council as follows: the Copley medal to Professor Elias Metchnikoff for the importance of his work in zoology and in pathology; the Rumford medal to Professor Hugh Longbourne Callendar for his experimental work on heat; a Royal medal to Professor Alfred George Greenhill for his contributions to mathematics, especially the elliptic functions and their applications; a Royal medal to Dr. Dukinfield Henry Scott for his investigations and discoveries in connection with the structure and relationships of fossil plants; the Davy Medal to Professor Rudolf Fittig for his investigations in chemistry and especially for his work in lactones and acids; the Darwin medal to Professor Hugo de Vries on the ground of the significance and extent of his experimental investigations in heredity and variation; the Hughes medal to Mrs. W. E. Ayrton for her experimental investigations on the electric arc and also upon sand ripples. The medals will, as usual, be presented at the anniversary meeting on St. Andrew's Day (November 30).

LORD RAYLEIGH has been recommended for reelection as president of the Royal Society and the other officers will be the same as last year, except that the following new members of the council have been nominated: Lord Avebury, Sir Benjamin Baker, K.C.B., Dr. H. F. Baker, Prof. David Ferrier, Prof. Sydney J. Hickson, Dr. Alexander Scott, Prof. A. C. Seward, Prof. W. J. Sollas, Prof. E. H. Starling, Prof. Silvanus P. Thompson, and Dr. A. D. Waller.

A PORTRAIT of Dr. Henry M. Hurd, superintendent of the Johns Hopkins Hospital, was presented to the hospital by the medical staff at a dinner given in honor of Dr. Hurd on November 1. Dr. William H. Welch presided at the dinner and made the presentation speech, and speeches were also made by Dr. Ira Remsen and Dr. D. C. Gilman. The portrait, which is by Mr. Chase, will be hung in the library. Dr. Hurd sailed for Europe on November 5, where he will remain for about a year.

IN the early part of October the Yale Association of Japan gave a reception in honor of Professor G. T. Ladd, who is now in Tokyo.

PROFESSOR TH. W. RICHARDS, who is going to Berlin in the second half year as Harvard's representative in the annual exchange of professors, will give while there a course of lectures on the 'Fundamental constants of physical chemistry.'

PROFESSOR L. H. BAILEY, director of the College of Agriculture, Cornell University, was elected president of the Association of Agricultural Experiment Stations at its recent meeting at Baton Rouge.

MME. CURIE gave her inaugural lecture at the Sorbonne on November 5.

WE learn from *The American Anthropologist* that the title of honorary curator has been conferred by the Cincinnati Museum Association on Mr. Philip M. Hinkle, who has undertaken the care of its collections relating to American archeology. With him are associated Mr. Frederick W. Hinkle and Dr. G. B. Rhodes.

MR. ROBERT H. BAKER, M.A., for three years assistant to Professor Todd, in Amherst Col-

lege Observatory, has received an appointment as assistant in the astrophysical observatory at Allegheny, Pa.

Dr. J. Gunnar Anderson has been appointed director-general of the Geological Survey, of Sweden.

Dr. Alfred C. Haddon, of Cambridge University, gave a lecture before the American Ethnological Society at the American Museum of Natural History on November 15.

Professor Charles Lane Poor, of Columbia University, gave a public lecture under the auspices of the New York Academy of Sciences and the American Museum of Natural History, on November 19, on 'The Proposed New Astronomical Observatory and Nautical Museum for New York City.'

A course of illustrated lectures on 'The Logical Evolution of Industries' is being given by Mr. Harlan I. Smith, of the American Museum of Natural History of New York, to the normal domestic art students at Pratt Institute, Brooklyn, during the school year 1906–7. The purpose of the course is to acquaint these prospective teachers of handwork with primitive arts and tools that they may more adequately instruct elementary school children in the simple forms of the industrial processes of modern life.

A prize has been established for proficiency in mineralogy in the Sheffield Scientific School in memory of the late Professor Penfield. The prize, of $25, is to be known as 'The Samuel Lewis Penfield Prize,' and is founded by a gift of $500 from Mr. Morris B. Belknap, of Louisville, Ky., of the class of 1877.

The statue of the late Principal Viriamu Jones, professor of physics and the first principal of the South Wales and Monmouthshire University College, has been temporarily placed, pending the completion of the new college buildings, at the City-hall, Cardiff.

Dr. A. F. Fokker, professor of hygiene and bacteriology at the University of Groningen, has died at the age of sixty-six years.

UNIVERSITY AND EDUCATIONAL NEWS.

The daily papers report that the sum of $500,000 has been offered to enlarge the university at Louisville, if an equal sum is contributed from other sources.

At the meeting of the Philadelphia County Medical Society on November 7, Dr. S. Weir Mitchell announced that Andrew Carnegie will give the College of Physicians, Philadelphia, $50,000 contingent on the college raising the sum of $100,000. The money is to be used in the erection of a new building.

The program of the Association of American Universities, which is meeting this week at Harvard University is as follows: Friday, November 23, 10 A.M., 'The Appointment and Obligations of Graduate Fellows.' Papers will be presented on behalf of Clark University, by Professor Hall; for the University of Wisconsin, by Professor Comstock. 2:30 P.M., 'The Exemption of Educational Institutions from Taxation.' Papers will be read on behalf of Harvard University, by President Eliot; for the University of Virginia, by Dr. J. W. Page. Saturday, November 24, 10 A.M., 'Should Men Bearing the Same Title in any Institution receive the Same Pay?' Papers will be presented on behalf of Stanford University, by President Jordan; for the University of Michigan, by Professor Hutchins.

The National Association of Presidents of the State Universities, which met at Baton Rouge last week, unanimously adopted the report of the committee on the University of the United States recommending the establishment of a national university by the government at Washington.

At the Montana State School of Mines, Charles Henry Bowman, M.S., secretary of the faculty, has been elected president. Professor Theodore Simons has been elected professor of engineering design.

Mr. T. D. A. Cockerell, lecturer in entomology at the University of Colorado, has been promoted to a professorship of systematic zoology. At the same institution, Dr. Saul Epsteen, Ph.D. (Zurich), has been promoted to an assistant professorship of mathematics.

Mr. A. C. Steward, tutor of Emanuel College, has been elected to the professorship of botany at Cambridge University, vacant by the death of Professor Marshall Ward.

SCIENCE

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THE PROMOTION OF AGRICULTURAL SCIENCE.

THE Society for the Promotion of Agricultural Science was founded in the year 1880, largely through the efforts of a few men, most of whom have now passed to their reward, who saw clearly the necessity for some such organization.

At that time the workers in agricultural science in the United States were few and scattered. While the oldest of the agricultural colleges had been in existence for some twenty-five years, these institutions were still comparatively feeble, with, in most cases, few students, and struggling for recognition. The first agricultural experiment station in the United States had been established but five years before and had been fully taken over by the state two years later. At the date of the foundation of this society, there existed in the United States three state experiment stations, two university stations and one private station, and few means were available for personal contact or exchange of ideas between investigators or for the publication of their results. The U. S. Department of Agriculture was a comparatively small affair, presided over by a commissioner, and its scientific work was chiefly that of its chemist, entomologist and veterinarian.

The twenty-six years which have since elapsed have witnessed a phenomenal development of agricultural education and investigation, and the young student of the present day can hardly realize the conditions which existed a generation ago. Now,

instead of half a dozen experiment stations, with an aggregate income of about twenty-two thousand dollars, we have, in the United States proper, sixty institutions, with a total income for the year 1904–5 of over one and a half million dollars. The U. S. Department of Agriculture has grown from a staff of one hundred and eight persons and an annual income of somewhat over two hundred thousand dollars, in 1881, to a great executive department with a total appropriation for the present fiscal year of nearly ten million dollars. The land grant colleges, too, from feeble and more or less destitute 'cow colleges' have acquired an acknowledged and honored position among the institutions for technical education, with a total endowment of ever eighty-one million dollars and an annual income of over eleven and three fourths million, with faculties aggregating two thousand six hundred and seventy-two and giving instruction to a total of nearly sixty thousand students, of whom nearly nine thousand are students of agriculture. In place of a few scattered bulletins and reports, issued in small editions, the experiment stations and the Department of Agriculture have become great publishing agencies, and instead of its being difficult to find a medium for the presentation of the results of investigation, the difficulty more often seems to be to find suitable material for the numerous publications called for by law or popular demand. Finally, the organic unity of these institutions as a class has been secured through the Association of American Agricultural Colleges and Experiment Stations. Surely this is a magnificent record for a little over a quarter of a century, and the end is not yet.

With this stupendous change in the situation, it might almost seem as if there were no function remaining for a society like this. Are not all these public institutions agencies for scientific investigation in agriculture on a scale and with resources such as to make a private organization superfluous? Is it still necessary to promote agricultural science?

Let us at the outset define our terms. By agricultural science we understand that body of scientific principles, known or discoverable, which underlies and conditions successful agriculture. By the promotion of agricultural science, we may understand the support of any measures calculated to give us a deeper and more comprehensive knowledge of these principles. In other words, it is equivalent to the promotion of scientific investigation in the field of agriculture. Investigation is scientific, as distinguished from practical, when it is undertaken with the prime object of enlarging our knowledge of principles and without immediate reference to practical application. Its incentive is the desire to know more rather than the ambition to do more.

Few members of this society, certainly, will question the fundamental importance of such investigation. They realize the truth of a recent remark by Dr. Welch,[1] of Johns Hopkins University, at the dedication of the new buildings of the Harvard Medical School, that, "The same phenomenon is exhibited in (medicine) as in all science that the search for knowledge with exclusive reference to its application is generally unrewarded." Research forms the ultimate basis of all agricultural as of all other progress, whether in the school, the college, the correspondence course or on the farm. I may be permitted to further emphasize this truth by quoting the words of one whose standing both as a scientific investigator and as a successful administrator is universally recognized."

[1] Science, October 12, 1906, p. 460.

At the jubilee of the University of Wisconsin, in 1904, Professor T. C. Chamberlin, of the University of Chicago, said:

> The fundamental and ulterior sources of education do not lie in the conventional schools, but back of them. These sources can not here be defined at length, but, in a simple phrase, they may be said to lie in the great stock of ideas possessed by mankind. This phrase inadequately embraces the whole, but let us agree that it may stand for the whole. In so far as the stock of ideas of a people is narrow, defective and erroneous, on the one hand, or broad, demonstrative and exact, on the other, in so far the fundamental subject-material of education partakes of these qualities. In so far as the sentiments, beliefs, attitudes and activities of a people are narrow, loose and perverted, on the one hand, or free, generous and ethical on the other, in so far education inevitably shares in these qualities. For these are the fundamental sources of education. The basal problem of education is, therefore, concerned with the entire compass of the intellectual possessions of a people, and, in a measure, of all mankind. The special selections propagated in the schools are but a miniature reflection of the total possession, and this selection is usually noble or mean, as the whole is noble or mean.
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> If these considerations are true, the fundamental promotion of education lies in an increase of the intellectual possessions of a people, and in the mental activities and attitudes that grow out of the getting, the testing and using of these possessions.
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> The education of the individual does not necessarily lift the education of the aggregate, for if we convey to the rising generation only such ideas as we have inherited, the summit level of education is not raised. There may be diffusion, there may be an evening up, but no lifting of the upper levels. If the intellectuality of the new generation does not rise above that of the old, there is only a Chinese dead level of ancestral propagation.
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> To secure laudable progress in the fundamental conditions of education, systematic provision for scientific research is necessary.

Granting now the need of scientific investigation in agriculture, as in other branches of human activity, let us inquire what are some of the conditions which favor or hinder it. A recent writer,[2] describing the 'needs of scientific men,' says:

> We neither expect scintillating 'success,' nor do we look forward to any prizes in the way of highly paid positions. Our needs are mainly two: (1) adequate time for work and (2) a living wage.

After mentioning two instances of the lack of time for scientific research among his acquaintances, he continues:

> The difficulty is intimately connected with the other one, that of the living wage. There is no living wage for *research;* research in pure science is at present a parasitic industry, to borrow a term from the economists. Both of the men I have just referred to get their salaries for doing economic work, and whatever they do in pure science is supported and made possible by the other. A still larger body of researchers lives upon the proceeds of teaching, while those who *actually get a living by research* are very, very few. The experiment stations, even, do not disobey the general rule, for the demand for immediate results of economic value is such that the workers are almost obliged, in the majority of cases, to desist from work of a broad and fundamental character, while most of them, of course, have to do a large amount of teaching.

In this last sentence there is indicated the serious danger that threatens agricultural research in the United States. Even a very cursory review of the changes of the last twenty-five years shows a wonderful record of progress on the material and practical side. We have vastly increased our equipment for agricultural investigation and added many-fold to the numbers presumably engaged in it, but it is the output of real scientific results, which will stand the test of time, commensurate with the increased facilities.

The agencies for agricultural investigation which have made such a phenomenal growth in the last quarter of a century were at first looked upon with suspicion or distrust by the public. They had to demonstrate their right to be supported from

[2] Cockerell, SCIENCE, August 11, 1906, p. 178.

the public purse, and to do this were compelled to take up first the pressing practical problems and to give research a secondary place. But their very success in demonstrating their usefulness, as shown by their increasing appropriations and by the change in the public temper familiar to all of us, threatens to be their permanent undoing as agencies of scientific research. From an attitude of skepticism the public has passed to one of undue credulity, and the experiment stations today have need to heed the ancient warning, 'Woe unto you when all men shall speak well of you! for so did their fathers to the false prophets.' Indifference has given place to urgent demands for assistance, and the pressure upon these institutions for facts of immediate practical utility, which shall justify to the public the liberality with which they are supported and lay the foundation for greater appropriations in the future, is so intense as to require unusual courage and breadth of vision on the part of him who will stand for the needs of real scientific investigation.

The ever-present tendencies toward premature and sensational exploiting of results and towards officialism in science are likewise dangers which need constantly to be guarded against. A recent writer, speaking of the reasons why agricultural science is often discredited with the practical man, says:

> Science, too, is sometimes responsible for another form of apparent contradiction (between the results of science and those of practical experience), many of her representatives being only too much inclined to generalize the results obtained in a special case, and in particular to publish prematurely. This error is more or less fostered both by officials and by agricultural organizations. When a report must be published yearly upon all sorts of scientific work, whether completed or not, in which case 'results' are naturally expected and planned for, there is produced a literary ballast that is a burden upon scientific work and which carries with it the serious danger that the agricultural public, before which these unripe fruits are zealously spread by the agricultural press (especially in the case of official reports), will feel the evil effects in its purse and will lose its appetite for all scientific results. The subsequent continuation of the investigations then develops the limitations, corrections and specializations and the unripe conclusions are altered or sometimes even entirely overthrown and admitted to be erroneous. This is most injurious to practical agriculture, and has already led to great losses and brought science into deserved disrepute.
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> In my opinion it is not at all essential to bring new achievements before the general public with the utmost promptness and to publish as much and as speedily as possible, but rather that all which is published shall be trustworthy and securely grounded, not only by individual investigation, but, as far as circumstances demand, by the due mention, consideration or critical discussion of whatever other investigators have previously said and discovered concerning the subject. Nowadays, the haste for publication has made it actually the fashion in many circles to ignore the available literature, or to pirate it, and to act as if one were the first who had laid this egg. It is often the case, too, that the reader is supplied only with summaries or other average or final figures, while all deeper insight into the course of development and the details of the investigation is prevented by their silent omission. This method of publication is unscientific and superficial, and he who uses it, especially when he avowedly substitutes the authority of his name, does not perhaps realize how great is the presumption toward the reader of which he is guilty in such a method of presentation.
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> The unholy thirst for notoriety, too, has alas struck deep root in agricultural science and has developed such vigorous shoots that it has become a shame for those who are guilty of it and has fairly compromised our science. Unfortunately, no one has yet been found to duly scourge and pillory the false and unscientific nature of these methods.
>
> All these growing evils are signs of degeneration. Let us guard ourselves against further cultivation of appearances and externalities. It is high time that modest, quiet, genuine work should take the place of this haste and false ambition, for agricultural science, as a relatively young science, stands in much too exposed a posi-

tion, in relation both to other sciences and to agricultural practise, to permit itself such laxities.

I quote these words from an article[3] by Professor von Rümker, of the University of Breslau in Germany.

Moreover, the agricultural experiment station in the United States has developed to a degree almost unknown in the land of its birth.

Twenty-five years ago the conception of an experiment station was that of a comparatively small institution exercising a police control over the manufacture and sale of certain agricultural products, notably fertilizers, and carrying on scientific research largely by laboratory methods. To a considerable degree this conception still obtains in foreign countries, but in the United States the stations have had an unexampled development. They are rapidly growing into great departments, touching the practise of agriculture in their several localities at all points, and the leaders in a vast propaganda for the elevation of rural life. We feel a just pride in this peculiarly American development of an adopted institution, and in the large measure of success which has attended it, but it would be foolish to shut our eyes to the accompanying dangers, and not the least of these is the drying up of the sources of power and inspiration by the failure to duly promote science along with practise. Not only does the pressure for results tend to the subordination of the scientific to the practical, but the management of these great institutions is making heavier and heavier demands on the time and energy of some of our best men. In fact, we seem to be developing a new type of leader in agriculture, comparable with the university president, who is primarily an administrator and whose chief function is to set other people at work. All honor to the successful administrator. Through his administrative work he is often a most efficient promoter of science. But let us not forget also to see to it that our system provides due honor and reward for the successful scientist and investigator. While the American type of experiment station is an admirable institution, and while the popular work of the stations and colleges is of vast importance and benefit, we must not forget that it all rests on the truths of science, and that unless science makes progress the popular work will soon be marking time.

[3] 'Landwirtschaft und Wissenschaft,' Berlin, Parey, 1905.

The year 1906 has witnessed a notable forward step in the development of agricultural investigation. The passage of the Adams act has doubled the United States appropriation to experiment stations, nominally in five and practically in four years. This fund differs from the Hatch fund in that the act specifies that it is to be used only for 'conducting original research or experiments.' It is not too much to say that the great opportunity offered by the passage of the Adams act, which has been the occasion for so much congratulation, will, like every other opportunity, prove also to be a day of judgment for the stations, in that it will reveal to all men their conception of original research, and demonstrate whether or not they have a broad fundamental grasp of the idea of investigation. Differences of opinion regarding the application of this fund are already apparent. The stations stand at the parting of the ways. Will they simply add demonstration to demonstration, propaganda to propaganda, or will they grasp the opportunity to dedicate this new fund sacredly and irrevocably to original scientific research, broadly conceived and liberally executed.

I shall, no doubt, be characterized as an idealist, as failing to recognize or appre-

ciate the need and the demand for popular work. An idealist I am and such I hope to remain, but I too know something of that desire for results and of that lively sense of appropriations expected which seldom fails to make itself felt by the station administrator. The situation is by no means without its difficulties, especially for those stations which exist to so large an extent under pioneer conditions. Were it otherwise, there would be little occasion for these remarks. The problem calls for strong men with an abiding faith in the fundamental and ultimate importance of scientific research. There is still need for the promotion of agricultural science. Times have greatly changed since a dozen gentlemen met in Boston in August, 1880, and founded this society, and some of the functions on which emphasis was then laid are now of less importance or have been otherwise provided for, but the great underlying purpose of the society, as expressed in its name, far from diminishing in importance has become even more vital to real progress.

What, then, may a voluntary organization, such as this, hope to do to promote agricultural science?

At no time since the society was founded has there been greater need for maintaining and raising the ideals of what science is and of what constitutes research. We are suffering to-day from a low and inadequate conception of scientific investigation. Now the conception of scientific investigation which is popularly current at any time depends very largely upon the attitude and ideals of the men of science themselves. The stream rarely rises higher than its source. It is of prime importance, therefore, that those professionally engaged in investigation in agriculture, whether in the experiment stations or elsewhere, should cherish a high ideal of their function in the body politic, and a high standard of professional and personal obligation. How can such ideals be more effectively maintained than by association. Scattered over three million square miles, and more or less isolated, we inevitably feel in our daily work the drag of the commonplace, the tediousness of the necessary drudgery which makes up such a large part of investigation, the temptation to cater to popular applause. What greater inspiration can we have than that which comes from an annual gathering such as this, where we meet, not as chemists or botanists, or entomologists, or directors, but simply as seekers after truth? Is not the mutual support, the discussion, the friendly criticism, which we encounter here a priceless factor in promoting agricultural science? In the conventions of the Association of American Agricultural Colleges and Experiment Stations, we meet officially, and seem tending more and more to the discussion of official and administrative problems. It is well to retain a meeting place frankly devoted to idealism.

But I believe the society may have other functions besides maintaining the ideals and strengthening the enthusiasm of its members. While it is essential that we maintain right ideals ourselves, it is equally important that we secure their acceptance by others. Few of us are so fortunate as to be able ourselves to defray the expenses of our own investigations. Most of us are dependent for the necessary funds upon the approval of boards of trustees or other superior officers, or, since these usually represent the public, we may say that we are dependent upon popular approval or at least tolerance. That research may take its rightful place, the public must come to understand better than it does the nature of research and its importance from the point of view of the general welfare.

Should not individuals and societies which stand for the promotion of science, while giving no less attention to specific results of investigation, take greater heed to the formation of an enlightened public opinion? We listened with pleasure and profit this afternoon to a discussion upon agricultural science in the experiment stations. Might it not be possible in the future to attract greater audiences to such discussions, and by means of suitable publication to bring them before the larger public? I feel sure that all legitimate influences ought to be brought to bear, whether in this or in other ways, to secure a generous and proper recognition of the importance of real scientific investigation in the work of our institutions for agricultural education and experimentation.

But such education of public opinion can not be effected in a month or a year; it must be a work of time, a gradual leavening of the lump. For the present, we can hardly expect otherwise than that the practical, so called, will predominate over the scientific in institutions supported by public funds. We are led to ask, therefore, whether any more immediately effective measures for the promotion of agricultural science can be devised.

Our minds naturally turn, in this connection, to the much-discussed question of the endowment of research. During the last few years we, along with others, have applauded the devotion of vast sums to this purpose, such as, to name two conspicuous examples, the endowment of the Carnegie Institution of Washington and of the Rockefeller Institute for Medical Research. We have rejoiced at the testimony afforded by these magnificent gifts to the estimate put upon the value of science and scientific investigation by hard-headed, successful men of affairs. We would not, if we could, subtract one dollar from the sums assigned by these and other like foundations to the support of any line of scientific inquiry, however abstruse. At the same time, we can not but regret that the great basal industry of this, as of every civilized country—the one which not only overtops all others in magnitude as measured in terms of money, but the one whose followers constitute the great conservative force of our national life—has thus far practically failed of recognition, and that the claims of agricultural science as a field for research have not thus far seemed to appeal to our men of wealth. I can hardly believe that this state of things will continue indefinitely. Wealth almost incalculable is being created annually by the American farmer, not for himself alone, but as well for the great transportation and manufacturing interests whose prosperity depends so directly upon his. Is it not reasonable to anticipate that if the importance of fundamental research in this field were properly set forth, free from the suspicion of personal interest, as it might be by a society like this, the Carnegie or the Rockefeller of agriculture would in due time appear, and that the great endowed universities would find a place for it in their programs?

These, then, are some of the larger objects which, as it seems to me, a Society for the Promotion of Agricultural Science should set before itself:

1. To aid in maintaining among our investigators in agriculture the highest ideals of scientific research, and to help to furnish the inspiration for the pursuit of these ideals.

2. To seek to educate the public to a greater appreciation of the need for scientific investigation into the underlying principles of agriculture and to a realization of the practical benefits flowing from it, and thus to promote the cause of agricultural

science in the experiment stations and kindred institutions.

3. To seek to impress upon university authorities, and upon wealthy donors, the claims of agricultural science to recognition as a most promising and attractive field for the endowment of research.

Is it not by setting before ourselves ends like these, even though they may seem somewhat utopian, that we shall most effectively promote agricultural science under existing conditions, rather than by simply meeting annually to read a few technical papers, too often prepared from a sense of duty or at the solicitation of the secretary, and paying a tax of two or three dollars to cover the cost of publishing them to an unappreciative world?

Finally, if the ideas which I have been advancing be not entirely quixotic, they suggest, to my mind at least, a radically different basis of organization from that which has prevailed hitherto.

At the outset, membership in this society was limited to forty, and the avowed purpose was to include only those who had already attained some degree of distinction in agricultural science. The idea in the minds of the founders, although nowhere perhaps clearly expressed, seems to have been to make membership in the society a distinction to be coveted. It was to be an American academy for agriculture, a sort of 'forty immortals.' Subsequently, the limits of membership have been greatly enlarged, yet in general the original conception has been adhered to, although not without struggles and heart burnings.

That conception was a high and worthy one, and that it has contributed notably to the promotion of agricultural science none can doubt. All honor to the men who at that early day embodied it in a concrete form.

But there is no impiety to their memory in asking whether the original form of organization is that best adapted to the changed conditions of the present day. Personally, I do not hesitate to say that I question this. The spirit of science is democratic and not aristocratic. In upholding her interests we need the help of everyone who has seen and loved her fair face. The man who has devoted half a lifetime to her service may be assumed to know and prize the modest rewards she offers. It is the young man, at the threshold of his career, dazzled by the glittering promises of business or commercial life, that we need to reach. If the society's influence is worth anything—if it affords any stimulus to worthy endeavor in the search after truth for its own sake—should not he especially have the benefit of it?

Moreover, why should we despise the aid of the man of affairs? If the promotion of agricultural science is also the promotion of the general weal, should we not rather welcome him as a new and powerful force through which to influence public opinion?

In brief, if the society accepts a comprehensive view of its mission, should it not make its basis of membership correspondingly broad, imposing no test except that of belief in the purposes of the organization and willingness to aid in forwarding them? It would still be possible to make a distinction, which need not be invidious, between those professionally engaged in agricultural science and those merely interested in its promotion on broad grounds of public policy, while the effectiveness of the society as an agent of propaganda would be immeasurably increased by such a broadening of its membership. The advantages of mere numbers, too, are not altogether to be despised. A larger membership, and more ample means, would bring within the range of possibility various

means of advancing the purposes of the society which now are entirely beyond our reach. The question of publication, for example, might present quite a different aspect under such conditions. The offering of prizes for the investigation or literary discussion of specified topics, the recognition by medal or otherwise of specially deserving investigations, even small grants in aid of research, loom up dimly on the horizon of possibility, but can not be further discussed here.

I am well aware that these suggestions may appear revolutionary. I have little faith in revolutions as a means of progress, but they have occasionally been unavoidable. We may as well frankly face the fact that for several years our society has been groping for a mission and that its meetings have been supported more or less from a sense of duty. I am not so presumptuous as to assume that I have found that mission. If my words serve to stimulate discussion and reflection concerning the functions of the society, they will accomplish all that I have any right to hope. True, we should beware of losing the substance while grasping the shadow, but, on the other hand, tradition should not blind us to the changed conditions confronting us. Are we not imperatively called upon to attempt in some way to make the work of this society such that the leaders of agricultural progress shall feel it worth their while to contribute to it liberally of their time and energy? If we can solve this problem we need have no apprehensions regarding the promotion of agricultural science.

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SCIENTIFIC BOOKS.

Soils. Their Formation, Properties, Composition and Relation to Climate and Plant Growth, in the Humid and Arid Regions. By E. W. HILGARD, Ph.D., LL.D., Professor of Agriculture in the University of California and director of the California Agricultural Experiment Station. The Macmillan Company. 1906. 8vo. Pp. xxvii + 593; 89 figures, including 37 photographic illustrations. $4.00 net.

In the production of this volume on soils Dr. Hilgard has enriched agricultural science throughout the domain of its most basal problems, and to a very notable extent. Moreover, its appearance at this time is extremely opportune, coming as it does with the initiation of more rigid research work by the agricultural experiment stations, before the Bureau of Soils has been able to fully discern what should be its own precise problems, and when the materials for agricultural education have yet to be definitely brought together in proper pedagogic form. It is now more than fifty years since Hilgard began the application of rigid research methods to the elucidation of the processes and principles which underlie and determine the productive power of soils. During most of this long period soil problems have been uppermost in his mind and have drawn from him, to their illumination, a large measure of his research effort. With mental traits of the highest research type; broadly and thoroughly trained at Zurich, Freiberg and Heidelberg before the days of extreme specialization in education, he entered upon this, his life study, with the best of equipment. Thrown directly into the field upon the humid, washed and leached soils of the south, from 1856 to 1872, in his agricultural and geological survey of Mississippi; then transferred to the glacial soils of Michigan from 1873 to 1875; and finally, for more than thirty years, studying the arid soils of the Pacific slope, during which time he was also attached to the agricultural division of the Northern Transcontinental Survey, and again brought back to reconsider the humid soils of the south when making his extended report upon cotton production for the tenth census, it is doubtful if any man living has been brought so persistently, widely and intimately to the personal study of soil types and soil conditions as he. And when it is

understood that throughout all of these extended studies soils have been considered broadly (1) from the standpoints of geology and climate; (2) from that of their physical composition, condition, moisture and aeration; (3) from that of chemistry and plant nutrition; (4) and finally from that of the correlation of native vegetation to virgin soil conditions as indicative of relative productive power a very important contribution to agricultural science may well be anticipated as the outcome of such preparation, especially when, as is the case here, the author fully avails himself of other investigations in setting out the subjects discussed.

Another feature which must give special importance to Hilgard's views as guardedly presented in this volume is the fact that throughout his half century of study he has been able to deal almost entirely with soils in their unfertilized or entirely virgin condition, whereas the whole of the soil literature of Europe had grown up on fields centuries old which had been long fertilized before the studies began; and what is more significant, our author, from the outset and throughout, was keenly alive to the fact that he was dealing with fundamental conditions which must be widely different from those which European students have met and from which they have drawn their conclusions.

The author groups his subjects into four parts: (1) the origin and formation of soils, covering 79 pages; (2) physics of soils, to which is devoted 237 pages; (3) chemistry of soils, appropriating 131 pages and (4) soils and native vegetation, to the consideration of which are given 62 pages. Those who have been in the habit of attributing to Hilgard the view that physical properties and conditions of soils play but a small part in determining their productive capacity will be surprised at the amount of space devoted to soil physics. This is done, not because of any change of views on the part of the author, for throughout all his writings no one has been more insistent regarding the greatest importance being attached to proper physical conditions as the first essential to a productive soil; and no one in America has done as much as he to establish the causes of the physical differences in soils which are productive and which are unproductive, and to point out practicable methods for correcting evils when they are known to exist. It has been his strong insistence during these later years, when it has become a fashion to ignore chemical differences, that these too are very important in influencing productive capacity, that has given the impression to some that Hilgard regards physical differences as of comparatively slight moment.

In Chapter I. the physical processes of soil formation are discussed, followed in the second by a presentation of the chemical, which includes the exchanges of bases in zeolites and the action of plants and their remnants in soil formation. Next come two chapters treating first of the major soil-forming minerals and then of the chief soil-forming rocks, where special stress is laid upon the nature, origin, determination and importance of colloidal clay as greatly influencing both the physical and chemical nature of soils; while in the last chapter of Part I. the minor minerals and ingredients of soils are treated, including those used as fertilizers and also those which are unessential or are injurious.

Part II. begins with the physical composition of soils and 'since clay is the substance whose functions and quantitative proportions influence most strikingly the agricultural qualities of land' it is first discussed. Then follows an important characterization of sands in humid and in arid regions, showing why the latter are usually and naturally so much more productive; the chapter closing with the methods, purposes and importance of mechanical analysis of soils. Chapters VIII., IX. and X., treating of soils and subsoils from the standpoints of causes and processes of differentiation; of organisms influencing soil conditions; of their relations to vegetation, and of the origin, nature and distribution of humus, will be found among the most luminous, important and suggestive, to both the student and the investigator, of all the valuable presentations which the book contains. Especially instructive is Fig. 27, contrasting a type of eastern soils with two of those of

California, showing the great differences in depth of the soil proper, thus giving a basis for understanding the possibility of deep humification, nitrification, root feeding and high duty of soil moisture which distinguish arid from humid soils, making them relatively more productive and more enduring. Chapters XI., XII. and XIII., in all 78 pages, are devoted to the water of soils, placing the greatest emphasis upon the problems of semi-arid and arid regions, while the remaining three chapters of this part deal with the absorption of solids from solution, and gases, the color of soils and climate.

Part III. is an extremely cogent and clear presentation of the author's and others' observations and conclusions regarding the legitimate functions, possibilities and utilities of chemico-physical investigations of soils in regard to crop production. A careful study of these chapters will be found a speedy and complete antidote for that miasma which rose up out of Maryland, infected the national capital and, on the wings of publicity, is developing 'toxic' symptoms at widely separated centers. The first chapter of this part, among other matters, gives a brief historical review of soil investigations; calls attention to advantages for soil study offered by virgin lands; points out the physical and chemical conditions of plant growth; discusses the solvent action of water upon soils; the ascertainment of immediate plant food requirements and chemical tests of immediate productiveness. The second chapter treats of the analysis of virgin soils by extraction with strong acids, the limits of adequacy of the several plant-foods in virgin soils and the influence of lime upon soil fertility, wherein it is held that 'a lime country is a rich country.' The next two chapters are given over to a very fruitful comparison of the soils of arid and humid regions, in which tropical soils, so far as data are available, come in for their share of consideration. The last two chapters of Part III., on alkali soils and the utilization and reclamation of alkali lands, all very comprehensive and practical discussion of those problems which must prove very helpful to agents of the reclamation service and to actual and intending settlers on those lands, 62 pages being very wisely given over to these important matters.

Soils and Native Vegetation is the title of Part IV. Quoting, but not consecutively, the author says:

> In newly settled countries, and still more in those yet to be settled, the questions of the immediate productive capacity, and the future durability of the virgin land are among the burning ones since they determine the future of thousands for weal or woe. This need has long ago led to approximate estimates, made on the part of the settler, by the *observations of the native growth, especially the tree growth.* * * * Thus in the long-leaf pine uplands of the Cotton States, the scattered settlements have fully demonstrated that after two or three years cropping with corn, ranging from as much as twenty-five bushels per acre the first year to ten and less the third, fertilization is absolutely necessary to farther paying cultivation. * * * Corresponding estimates based upon the tree growth and in part also upon minor vegetation, are current in the richer lands also. The 'black-oak and hickory uplands,' the 'post-oak flats,' 'hickory bottoms,' 'gum bottoms,' 'hackberry hammocks,' 'post-oak prairie,' 'red-cedar prairie' and scores of other similar designations, possess a very definite meaning in the minds of farmers and are constantly used as a trustworthy basis for bargain and sale, and for crop estimates. * * * Since the native vegetation normally represents the results of secular or even millennial adaptation of plants to climatic and soil conditions, this use of the native flora seems eminently rational. * * * It seems singular that such well and widely understood designations and important distinctions should not long ago have been made the subject of careful investigation and precise definition by agricultural investigators. For apart from their practical importance as guides to the purchaser of land, or settler, this correlation of land values and natural vegetation is of the utmost interest in offering an opportunity for researches on the factors which determine the choice of these several trees and their corresponding shrubby and herbaceous growths. * * * Only very fragmentary and casual observations in this line are on record thus far. * * * Yet, to ascertain by the physical and chemical examination of soils what are determining factors of certain natural vegetative preferences, which are invariably followed by certain agricultural results, should not be an unsolved

problem and its practical importance should justify its most active investigation.

The author gives in some detail, fully illustrating his thesis, the results of his early studies in Mississippi along these lines, presenting in Figs. 79, 80 and 81 the most striking illustrations of how individuals of one and the same species of post-oak, black-jack oak and deciduous cypress persistently differ in both stature and habit of growth when they recur on the same soil types in different localities throughout the state; finally extending the discussion to observations in the United States at large and to Europe. I can not do better, in closing the review of this valuable work, than to quote again the author where he is discussing the influence of lime in the soil on the character of floras.

> What is a calcareous soil? The definition adopted for this volume has been given in a previous chapter; viz., that a soil must be considered calcareous so soon as it naturally supports a calciphile flora—the lime vegetation so often referred to above and named in detail. Upon this basis it has been seen that some (sandy) soils containing only a little over one tenth of one per cent. of lime show all the characters and advantages of calcareous soils; while in the case of heavy clay soils, as has been shown, the lime-percentages may rise to over one half per cent. to produce native lime growth.

At first thought it may appear to some that the adoption of such a definition is a subterfuge to make observations harmonize with theory, but it is not so. Every one will agree that a moist soil, defining it from the standpoint of plant nutrition, is one which will yield moisture to a plant as rapidly as it is needed. On this basis a sandy soil containing 4 per cent. of moisture is as moist as a clay soil carrying 20 per cent., the physiological difference being determined chiefly by the relative amounts of internal soil surface in the two cases.

This volume should be introduced to a much wider circle of students than those of the agricultural colleges generally. It will be found well suited to serve as the foundation of important seminars in chemistry, in geology and especially in plant physiology and ecology.

F. H. King.

October 30, 1906.

HATCH AND CORSTORPHINE'S GEOLOGY OF SOUTH AFRICA.[1]

The visit of the British Association to South Africa was the occasion for the appearance of two noteworthy books on the geology of that region: Rogers's 'Geology of Cape Colony,' and Hatch and Corstorphine's 'Geology of South Africa.' The latter is the more general of the two, as it treats of much the larger area; the former is somewhat more detailed, as all of its space is devoted to the formations that occur in the single colony with which it is concerned.

The small geological map, scale, 1:5,000,000, which serves as frontispiece to Hatch and Corstorphine's book, provides a good introduction to the problems considered in the text. The greater part of the area described is occupied by the nearly horizontal beds of the Karroo system, a vast body of continental deposits which has shared the fate of other stratified formations not containing marine fossils in having been explained by earlier observers as a lacustrine deposit, but which is now recognized as of mixed origin. Its lowest member is the famous Dwyka glacial conglomerate, or 'tillite,' as Penck has suggested it should be called, unquestionably of glacial origin. The overlying members of great thickness are probably of mixed fluviatile and lacustrine deposition, as they contain beds of coal and fossils of reptiles, as well as numerous dikes and sheets of dolerite. This great body of continental formations occupies a geosynclinal basin, some 600 miles east and west by 400 miles or more north and south. It is obliquely truncated by the seacoast on the southeast; there the ancient lands from which the basin deposits were derived, appear to have been lost in the Indian Ocean. On the south, the Karroo system and the underlying formations are folded in long east-and-west anti-

[1] Macmillan, 1905, 348 pages, 2 geol. maps, 89 figures and plates. $7.00.

clines and synclines which present in structure and topography many resemblances to the Alleghenies of Pennsylvania. The older formations here involved include many sandstones, of which the Table mountain series is the basal and heaviest member. The very ancient Malmesbury series, under the Table mountain sandstone, is presumably of Archean date; it consists largely of slates, with bodies of intrusive granites. This fundamental complex is exposed chiefly to west of the Karroo basin, as far as the Atlantic. A recent paper by Rogers, of the Cape Colony survey, announces the discovery of a very ancient glacial deposit, much more indurated than the Dwyka tillite, in this series of fundamental rocks.

The older formations that underlie the Karroo system in the Transvaal, on the north, are much more complicated than those on the southwest. Beginning at the base there are Archean schists and slates, with granitic intrusions; over these comes unconformably the Witwatersrand system, famous for its gold-bearing Banket or pudding-stone; then follows after a second unconformity the Ventersdorp system with heavy amygdaloids; and again after a third unconformity, the Potchefstroom system. This entire complex series was deformed by folds of moderate intensity and greatly eroded before a northern equivalent of the Table mountain sandstone, called the Waterberg sandstone, was deposited; and this in turn was heavily eroded before the first member—the Dwyka tillite—of the Karroo system was formed. A geological map of this region by Hatch on a scale of 1:1,250,000, is given at the end of the book.

The younger rocks are chiefly of Cretaceous age, near the southern and eastern coasts. The 'pipes' of diamond-bearing volcanic rocks are also younger than at least some of the Karroo formations, inasmuch as the Karroo members are cut through by the pipes. The diamond mines of Kimberly and Pretoria and the gold mines of the Rand are described in some detail. The last chapter of the book treats the correlation of the pre-Dwyka formations, which are mostly non-fossiliferous, so that the occurrences in widely separated areas are of difficult identification. An excellent list of papers on South African geology and an index close the volume.

W. M. D.

'Gli Insetti, loro organizzazione, sviluppo, abitudini e rapporti coll'uomo. By Professor ANTONIO BERLESE, director of the Royal Station for Agricultural Entomology in Florence. Milan, Societá Editrice Libraria. 1906. Published in parts at one lira each.

With such excellent recent general American books on insects as those of Kellogg and Folsom, it would seem difficult for a book in a foreign language to meet any great demand in this country, yet the admirable work of Professor Berlese, of which seventeen parts have already been published, will undoubtedly prove a very important addition to the libraries of all institutions in which advanced morphology is being studied and in all laboratories in which the study of insects is undertaken from any point of view.

Berlese is a master, a man of broad ideas, thorough training, admirable in technique, clear in demonstration, an excellent writer, and a capable draftsman. His work when completed will be both sound and comprehensive. It will comprise two volumes, of which the first will in a general way contain the anatomy and the second the biology of insects. The first volume will consist of from seven to eight hundred pages and will be accompanied by about one thousand figures. Of these, 550 pages have been published in seventeen parts, and the printed parts contain six hundred figures and four plates.

The subjects considered in the first volume, by chapters, are:

I. Brief History of Entomology.
II. Size of Insects.
III. Plan of the Insect Structure.
IV. Embryology in General.
V. Morphology in General.
VI. Exoskeleton.
VII. Endoskeleton.
VIII. Muscular System.
IX. Integument and its Structure.
X. Glands.

There still remain to be published chapters on the nervous system and organs of sense, organs of digestion, organs of circulation, organs of respiration, organs of secretion, and sexual organs. In the part already completed the chapters on morphology are marvels of detail and thoroughness. The work itself is a large octavo, and more than ninety pages are devoted, for example, to the study of the exoskeleton of the head, while nearly eighty pages are occupied with the treatment of the muscular system. Nearly all of the numerous and strikingly apt illustrations are original, having been drawn by Dr. Berlese himself. Each section of the work is followed by a very complete bibliography, and the author has shown a perfect knowledge of the work of other men, the publications of American authors having been considered and studied with a thoroughness quite unusual among European authors.

The second volume, which has been reserved for the treatment of biology of insects, will contain a careful consideration of all questions of economic importance, and it will undoubtedly be of interest to learn from this work Berlese's final views on the subject of parasitism, and especially the relations of insects and birds upon which point he has long been at odds with other Italian zoologists.

L. O. Howard.

SCIENTIFIC JOURNALS AND ARTICLES.

The October number (volume 7, number 4) of the *Transactions of the American Mathematical Society* contains the following papers:

O. Bolza: 'Weierstrass's theorem and Kneser's theorem on transversals for the most general case of an extremum of a simple definite integral.'

J. Pierpont: 'Area of curved surfaces.'

W. A. Manning: 'On multiple transitive groups.'

L. Stickelberger: 'Zur Theorie der vollstandig reduciblen Gruppen, die zu einer Gruppe linearer homogener Substitutionen gehören.'

L. E. Dickson: 'On commutative linear algebras in which division is always uniquely possible.'

H. F. Blichfeldt: 'On the order of linear homogeneous groups.'

J. I. Hutchinson: 'On automorphic groups whose coefficients are integers in a quadratic field.'

F. R. Moulton: 'A class of periodic solutions of the problem of three bodies with application to the lunar theory.'

J. H. McDonald: 'A problem in the reduction of hyperelliptic integrals.'

C. N. Haskins: 'On the differential invariants of a plane.'

This number contains also: Notes and Errata, volumes 6, 7; Table of Contents, volume 7.

The November number (volume 13, number 2) of the *Bulletin of the American Mathematical Society* contains: Report of the Thirteenth Summer Meeting of the American Mathematical Society, by F. N. Cole; Report of the New Haven Colloquium, by Virgil Snyder; 'Theory and Construction of Tables for the Rapid Determination of the Prime Factors of a Number,' by Ernest Lebon (translated by W. B. Fite); 'On a Fundamental Relation in Abstract Geometry,' by A. R. Schweitzer; 'On the Orderly Listing of Substitutions,' by D. Lehman; 'The Boston Colloquium' (Review of Lectures on Mathematics by E. B. Van Vleck, H. S. White, F. S. Woods) by J. I. Hutchinson; Correction; Notes; New Publications.

SOCIETIES AND ACADEMIES.

NATIONAL ACADEMY OF SCIENCES.

The autumn meeting of the academy was held on Tuesday, Wednesday and Thursday, November 20, 21 and 22, in the new buildings of the Harvard Medical School, Boston. The list of scientific papers was much longer than it has been at any session of the academy in recent years. It was, indeed, necessary to read by title many of the papers, which according to the program were as follows:

Alexander Graham Bell: 'A few Notes Concerning Progress in Experiments relating to Aerodromics.'

William Edward Story, Clark University (introduced by A. G. Webster): 'A Method for the Enumeration of Algebraic Invariants.'

Arthur Gordon Webster, Clark University: 'Acoustic Measurements.'

W. T. Porter, Harvard Medical School (intro-

duced by H. P. Bowditch): 'Vasomotor Relations.'

ARTHUR A. NOYES and others, Massachusetts Institute of Technology: 'The Conductivity, Ionization, and Hydrolysis of Salts in Aqueous Solution at High Temperatures.'

R. S. WOODWARD, Carnegie Institution, Washington: 'Theory and Application of the Double Suspension Pendulum.'

RUSSELL H. CHITTENDEN, Yale University: 'The Minimal Proteid Requirement of High Proteid Animals.'

GILBERT N. LEWIS, Massachusetts Institute of Technology (introduced by A. A. Noyes): 'The Free Energy of Oxidation Processes.'

GEORGE W. PIERCE, Harvard University (introduced by John Trowbridge): 'Wave-length Measurements in Wireless Telegraphy.'

EDWIN H. HALL, Harvard University (introduced by John Trowbridge): 'Measurement of the Thomson Thermoelectric Effect in Metals.'

JOHN TROWBRIDGE, Harvard University: 'Analogy between Electrical Energy and Nervous Energy.'

JOSEPH BARRELL, Yale University (introduced by W. M. Davis): 'Continental Sedimentation with Applications to Geological Climates and Geography.'

THEODORE LYMAN, Harvard University (introduced by John Trowbridge): 'Light of Extremely Short Wave-length.'

W. M. DAVIS, Harvard University: 'The Eastern Slope of the Mexican Plateau.'

ELLSWORTH HUNTINGTON, Harvard University (introduced by W. M. Davis): 'Evidence of Desiccation during Historic Times discovered in Chinese Turkestan in 1905–06.'

WILLIAM H. PICKERING, Harvard University (introduced by E. C. Pickering): 'Planetary Inversion and the tenth Satellite of Saturn.'

S. I. BAILEY, Harvard University (introduced by E. C. Pickering): 'The Work of the Bruce Telescope.'

THEODORE W. RICHARDS, L. J. HENDERSON and H. L. FEVERT, Harvard University: 'The Heat of Combustion of Benzol.'

THEODORE W. RICHARDS and GEORGE S. FORBES, Harvard University: 'The Atomic Weights of Nitrogen and Silver.'

ROBERT T. JACKSON, Harvard University (introduced by E. L. Mark): 'Structure of Richthofenia.'

W. E. CASTLE, Harvard University (introduced by E. L. Mark): 'On the Process of Fixing Characters in Animal Breeding.'

E. L. MARK and J. A. LONG, Harvard University: 'The Maturation of the Mammalian Ovum.'

E. L. MARK, Harvard University: 'The Marine Biological Station at La Jolla, Cal.'

G. H. PARKER, Harvard University (introduced by E. L. Mark): 'Reactions of Amphioxus to Light.'

H. C. JONES, John Hopkins University (introduced by Ira Remsen): 'The Absorption Spectra of Solutions in Relation to the Present Hydrate Theory.'

S. F. ACREE, Johns Hopkins University (introduced by Ira Remsen): 'On the Salts of Tautomeric Compounds.'

CHARLES P. BOWDITCH, Peabody Museum (introduced by F. W. Putnam): 'The Temples of the Cross, of the Foliated Cross, and of the Sun, at Palenque, Mexico.'

GEORGE C. COMSTOCK, University of Wisconsin: 'Extent and Structure of the Stellar System.'

HENRY F. OSBORN, Columbia University: 'Tyrannosaurus: Upper Cretaceous Carnivorous Dinosaur.'

HENRY F. OSBORN, Columbia University: 'Section of American Tertiaries.'

HENRY F. OSBORN, Columbia University: 'Complete Mounted Skeleton of Fin-back Lizard Neosaurus of the Peruvian.'

OTTO FOLIN, McLean Hospital (introduced by H. P. Bowditch): 'Metabolism of Creatin and Creatinin.'

CHARLES S. MINOT, Harvard Medical School: 'Nature and Cause of Old Age.'

C. S. PEIRCE, Milford P. O., Pa.: 'Phaneroscopy, or Natural History of Signs, Relations, Categories, etc.' A method of investigating this subject expounded and illustrated.

BAILEY WILLIS, U. S. Geological Survey (introduced by Charles D. Walcott): 'Heterogeneous Elements of the Continent as Factors in the History of North America.'

S. C. CHANDLER: 'Present State of Knowledge as to Motions of the Terrestrial Pole.'

CHARLES R. VAN HISE, University of Wisconsin: 'The Origin of the Ores of the Cobalt-silver district of Ontario.'

CHARLES D. WALCOTT, U. S. Geological Survey: 'Geological and Biological Study of the Cambrian Brachiopods.'

J. M. CRAFTS, Boston: 'The Catalysis of Sulphuric Acids.'

W. B. SCOTT, Professor of Geology, Princeton: 'The Miocene Mammals of Patagonia.'

GEORGE E. HALE, Director of the Solar Observatory of the Carnegie Institution: 'Sun-spot

Spectra, and their Bearing on Stellar Evolution.'

For the first time a conversazione was held in connection with the meeting. The exhibits, according to the program, were as follows:

ARTHUR A. NOYES, professor of theoretical chemistry, Massachusetts Institute of Technology: Platinum lined bomb with insulated electrodes for electrical conductivity measurements with solutions at high temperatures and pressures.

THEODORE W. RICHARDS, professor of chemistry, Harvard University: Apparatus used in the precise determination of chemical and physicochemical constants including the nephelometer, the adiabatic calorimeter, the device for excluding moisture from fused salts, and other apparatus.

J. B. WOODWORTH, assistant professor of geology, Harvard University (introduced by W. M. Davis): Fossil foot-prints, including those of amphibians, from the Carboniferous shales of Plainville (Wrentham), Mass.

W. M. DAVIS, professor of geology, Harvard University: Diagrams illustrating a method of reconstructing the original course of a river, now flowing in an incised meandering valley.

JOSEPH BARRELL, assistant professor of geology, Yale University (introduced by W. M. Davis): Continental deposits of fluvial origin as indicators of geography and climate. Subaerial conglomerates, standstones and shales: (1) From the Mauch Chunk Shale (Sub-carboniferous) of eastern Pennsylvania; (2) from the lower Coal Measures (Carboniferous) of eastern Pennsylvania; (3) from the Newark Shale (Triassic) of Connecticut and New Jersey.

B. K. EMERSON, professor of geology, Amherst College (introduced by W. M. Davis): A new geological map of Massachusetts.

W. NORTH RICE, professor of geology, Wesleyan University: Superintendent Connecticut Geological and Natural History Survey (introduced by W. M. Davis): Geological map of Connecticut, on scale of four miles to the inch, by H. E. Cryary and H. H. Robinson, to be published by the State Geological and Natural History Survey.

T. A. JAGGAR, JR., head of the department of geology, Massachusetts Institute of Technology (introduced by W. M. Davis): Apparatus and product of experiments illustrating the mechanism of rill erosion. Diagrams, photographs, and apparatus.

HENRY F. OSBORN: (1) Recent restorations of extinct horses of North America, executed by Charles R. Knight, under direction of Henry F. Osborn, (*A*) water-colors, (*B*) photographs; (2) first complete section of the American Tertiaries,—a preliminary study.

R. DEC. WARD, assistant professor of climatology, Harvard University (introduced by W. M. Davis): Some new curves illustrating types of temperature, rainfall and cloudiness in the torrid and the temperate zones. These curves show the variations in the different elements month by month throughout the year.

CHARLES P. BOWDITCH, member of faculty of the Peabody Museum (introduced by F. W. Putnam): The temples of the cross, of the foliated cross, and the sun, at Palenque. Maudslay's plates of Palenque.

ELLSWORTH HUNTINGTON, holder of Hooper Fellowship, Harvard University (introduced by W. M. Davis): Buddhist manuscripts, records and letters inscribed on wooden tablets in the Kharoothi language, small plaster figures from a Buddhist lamasery, cord shoes, small plates of leather armor, etc., dating from about the third or fourth century A.D., and collected by the exhibitor in 1905 from the sand-buried ruins in the Taklamakan desert in western China.

F. W. PUTNAM, curator of the Peabody Museum of Harvard University: Copies of mural paintings from the temple of the tigers, Chicken Itza, Yucatan. Copied by Miss Adela C. Breton.

E. C. PICKERING, professor of astronomy, Harvard University—Harvard College Observatory: Recent work of the Harvard College Observatory; illustrated by diagrams, etc. Discovery of variable stars and satellites; methods and results. Studies in stellar spectra and in lunar detail; Peruvian meteorology; diurnal variations at different altitudes.

C. S. SARGENT, Arnold Arboretum, Boston: Silvicultural exhibit.

A. F. BLAKESLEE, Harvard Botanical Museum, instructor in botany (introduced by W. G. Farlow): Earliest states of sexuality in plants, illustrated by cultures of fungi.

M. A. CHRYSLER, instructor in botany, Harvard University (introduced by G. L. Goodale): Cambium in the monocotyledons.

CHARLES S. MINOT, professor of comparative anatomy, Harvard University: Evolution of the automatic microtome; Harvard embryological methods.

HAROLD C. ERNST, professor of bacteriology, Harvard University (introduced by W. T. Councilman): Ultra-violet photomicrography and methods of use.

J. H. WRIGHT, director of clinico-pathological

laboratory, Massachusetts General Hospital (introduced by W. T. Councilman): Demonstration of the histogenesis of the blood plates.

F. B. MALLORY, associate professor of pathology, Harvard University (introduced by W. T. Councilman): Demonstration of intracellular substances, and differential methods of staining.

E. E. SOUTHARD, assistant professor of neuropathology, Harvard University (introduced by W. T. Councilman): Demonstration of nerve cells and neuroglia.

S. B. WOLBACH, instructor in pathology, Harvard University (introduced by W. T. Councilman): Demonstration of two pathogenic fungi related to genus *Oidium* exhibiting changes in morphology and protective phenomena when inoculated into animals.

W. T. PORTER, professor of comparative physiology, Harvard Medical School (introduced by H. P. Bowditch): Improved kymographions.

M. L. FERNALD, assistant professor of botany, Harvard University (introduced by G. L. Goodale): Certain plants in eastern Canada.

E. C. JEFFREY, assistant professor of vegetable histology, Harvard University (introduced by G. L. Goodale): Photographic and photomicrographic illustrations of Cretaceous plants.

OAKES AMES, assistant director of the botanic garden, Cambridge (introduced by G. L. Goodale): New orchids from the Philippines.

G. L. GOODALE, professor of botany, Harvard University: A new form of 'container' for museums of botany, plaster-plaques for museums, selections from recent photomicrographs of fibers.

E. E. TYZZER, director of cancer research laboratory, Harvard University (introduced by W. T. Councilman): Photomicrographs illustrating the dermatitis produced by the Brown Tail moth.

W. B. CANNON, professor of physiology, Harvard University (introduced by H. P. Bowditch): Movements of the stomach and intestine as seen in the zoetrope.

ARTHUR GORDON WEBSTER, professor of physics, Clark University: A set of instruments for the performances of quantitative researches in acoustics.

J. C. BRANNER, professor of geology, Stanford University: Album of photographs relating to the geology of the California earthquake of April 18, 1906.

THEODORE LYMAN, instructor in physics, Harvard University (introduced by John Trowbridge): Photographs of short wave-lengths.

GEORGE C. COMSTOCK, director of the Washburn Observatory: Pendulum apparatus for the determination of the force of gravity.

W. B. SCOTT, professor of geology, Princeton University: Drawings and plates of fossil mammals, etc., for the reports of the Princeton University expeditions to Patagonia. Also published parts of reports.

BAILEY WILLIS, Geologist, U. S. Geological Survey (introduced by Chas. D. Walcott): Geological map of North America, prepared for the International Geological Congress at the City of Mexico.

CHARLES S. MENDENHALL, professor of physics, University of Wisconsin (introduced by George C. Comstock): New apparatus for pendulum determinations of gravity.

LOUIS KAHLENBERG, professor of chemistry, University of Wisconsin (introduced by Charles R. Van Hise): Apparatus for the investigation of osmotic pressures.

CHARLES F. BURGESS, professor of applied electro-chemistry, University of Wisconsin (introduced by George C. Comstock): Exhibits in applied electro-chemistry.

E. L. MARK, Hersey professor of anatomy, Harvard University: A machine for cutting wax reconstruction plates by means of an electrical device; a paraffine bath heated by electricity.

G. H. PARKER, professor of zoology, Harvard University (introduced by E. L. Mark): *Mistichthys luzonensis*, the smallest vertebrate.

W. E. CASTLE, assistant professor of zoology, Harvard University (introduced by E. L. Mark): Wild and tame guinea-pigs and hybrids between the two.

ROBERT T. JACKSON, assistant professor of paleontology, Harvard University (introduced by E. L. Mark): Binocular preparative microscope.

J. E. WOLFF, and C. PALACHE, professor, Harvard University (introduced by W. M. Davis): Examples of recent instruments, models, etc., for the study and exposition of mineralogy, petrography, and optical mineralogy.

A. G. WEBSTER, Clark University, Worcester: Dynamical tops.

GEORGE E. HALE, director of the solar observatory of the Carnegie Institution: Photographs and drawings from the solar observatory.

C. BARUS, Brown University, Providence: Charts of the distribution of atmospheric nucleation in the lapse of time.

From four to five o'clock an exhibit of lantern slides was made in the lecture room on the first floor, by Professors S. I. Bailey,

E. C. Jeffrey, A. G. Webster, Harold Ernst and E. E. Southard.

NEW YORK STATE SCIENCE TEACHERS' ASSOCIATION.

THE next annual meeting of the New York State Science Teachers' Association will be held at Teachers College, Columbia University, New York City, December 26 and 27.

The program is as follows:

WEDNESDAY AFTERNOON.

DEAN JAMES E. RUSSELL, address of welcome.

DR. KELLY, Ethical Culture School: 'Are High School Courses in Science adapted to the Needs of Adolescents.'

J. M. JAMESON, Pratt Institute, Brooklyn: 'More Interesting Mechanics.'

PROFESSOR MINCHEN, University of Rochester: demonstration, 'The Principle of Interference and its Applications.'

HENRY R. LINVILLE, De Witt Clinton High School, New York City: 'Biology as Method and as Science in Secondary Schools.'

DR. GRACE E. COOLEY, Newark High School: 'The High School Biologist and the Citizen of Tomorrow.'

JENNIE T. MARTIN, Central High School, Buffalo: 'Field Work in Physical Geography.'

W. H. PLATZER, High School, Poughkeepsie: 'The Value of the Inductive Study of Relief Forms in Field Work.'

PROFESSOR GALE, University of Rochester: 'The Place of Transformation Theory in Geometry.'

PROFESSOR KEYSER, Columbia University: 'Concerning the Introduction of Modern Notions into the Geometry of Secondary Mathematics.'

WEDNESDAY EVENING.

PROFESSOR D. E. SMITH, Teachers College, Columbia University: 'The Preparation of the Teacher of Mathematics in Secondary Schools.'

PROFESSOR E. L. THORNDIKE, Teachers College, Columbia University: 'Science Teaching seen from the Outside.'

THURSDAY FORENOON.

PROFESSOR MANN, Chicago University: 'The New Move for the Reform of Physics Teaching in Germany, France and America.'

PROFESSOR SHERMAN DAVIS, Indiana University: 'Purpose of Science in the Culture of the Adolescent.'

W. M. BENNETT, West High School, Rochester: 'Some Demonstrations in Refraction and Dispersion of Light.'

J. Y. BERGEN, Cambridge, Mass.: 'Plant Physiology in Secondary Schools.'

PROFESSOR BIGELOW, Teachers College, Columbia University: 'Some Established Principles of Nature Study.'

LESTER B. GARY, High School, Buffalo; GEORGE T. HARGITT, High School, Syracuse, and JAMES T. PEABODY, Morris High School, New York City: 'The Teaching of Biological Science in some of the High Schools in New York State.'

PROFESSOR RICHARDSON, Syracuse University: 'The Study of Minerals and Rocks in Physical Geography in the High School.'

DR. JOHN M. CLARKE, State Geologist, 'Barachois, Bar and Tickle.'

A. W. FARNHAM, Oswego Normal School: 'The Relation which School Gardens may bear to Industrial and Commercial Geography.'

W. T. MORREY, Morris High School, New York City: 'Use of Reference Books in Physical Geography by Pupils in the High School.'

PROFESSOR HAWKES, Yale University: 'Secondary Mathematics from a College Standpoint.'

C. E. BIKLÉ, Horace Mann High School: 'What Equipment does a High School need for the Effective Teaching of Mathematics.'

PROFESSOR WEBB, Stevens Institute: 'The Relation between High School and College Mathematics.'

THURSDAY AFTERNOON.

PROFESSOR HALLOCK, Columbia University, demonstration: 'Optical Oddities.'

FRED Z. LEWIS, Boys' High School, Brooklyn, demonstration: 'Photomicrographs.'

PROFESSOR DAVIS, Harvard: 'Laboratory Exercises in Physical Geography,' illustrated.

W. BETZ, East High School, Rochester: 'Open Questions in the Teaching of Elementary Geometry.'

The President of the Association of Teachers of Mathematics in the Middle States and Maryland: 'The Necessity of Closer Affiliation of Mathematical Associations.'

DR. E. O. HOVEY, American Museum of Natural History: 'West Indian Volcanoes and their Recent Eruptions,' illustrated.

THURSDAY EVENING.

Lecture by Professor C. M. Woodward, and reception by the trustees of Columbia University.

TEACHERS COLLEGE, COLUMBIA UNIVERSITY,
JOHN F. WOODHULL.
NEW YORK CITY.

NEW YORK ACADEMY OF SCIENCES. SECTION OF GEOLOGY AND MINERALOGY.

AT a meeting on Monday, October 8, the following papers were read:

Notes on the Microscopic Examination of the Opaque Constituents of Ore Bodies: Dr. WILLIAM CAMPBELL. (Illustrated with lantern slides.)

The first part of the paper dealt with the preparation of the specimen for examination; of the various types of microscopes used; and the means of obtaining illumination by reflected light. Next the paragenesis of the constituents of certain alloys was shown by microphotographs. Lastly the methods were applied to the opaque constituents of ores from Butte; the cochise district of Arizona; Ducktown, Tenn.; Rossland, B. C.; Sudbury, Ont.; southeast Missouri, etc.

Notes on the Preglacial Channels of the Lower Hudson Valley as revealed by Recent Borings: Dr. C. P. BERKEY.

Borings made by the Board of Water Supply of New York City, in connection with the project of bringing water from the Catskill Mountains, have shown the existence of numerous deeply buried channels representing preglacial stream courses. Many of them indicate channels cut far below present sea level at considerable distances back from the Hudson River. From engineering records it appears that the depth to bed-rock in the Hudson River has never been determined at any point in its lower course. Profiles of supposed rock-bottom based upon wash-borings have been proven by the recent work to represent simply the bottom of the finer silt filling. The results show that more than 200 feet of more compact material lies below this silt at the point now being tested, and that the rock bottom of the ancient Hudson lies more than 450 feet below the present river level throughout a large part of its lower course.

Notes on the Character and Origin of the Pottsville Formation of the Appalachian Region: Dr. A. W. GRABAU.

The character of the overlap of the several divisions of the Pottsville, and the material and type of cross-bedding were discussed and the conclusion reached that the formation is of the nature of an alluvial cone—or several confluent ones, with occasional marine intercalations.

Professor D. S. Martin exhibited a large crystal of pink beryl, which he had lately obtained at Haddam Neck, Conn. The old quarry in the albite pegmatite at this locality, long famous for its colored tourmalines, is not now being worked; but a new one has been opened closely adjacent, and apparently on a continuation of the same vein or dike. This one has yielded less tourmaline than the former, but much more beryl, and particularly the heretofore very rare pink variety. Of these, a number of fine large crystals have been obtained, comparable with those lately developed from the gem-tourmaline mines in San Diego County, California.

The present specimen measures about four inches in both length and diameter; it is a fine termination, of the type characteristic of this variety. It has been recently shown by Ford (*Am. J. Sci.*, Sept., 1906) that these pink beryls, from whatever locality, present a peculiar type of crystallization. Instead of the long hexagonal prism with flat basal termination, usually seen in the green beryls of New England, the pink ones tend to a strong development of pyramidal planes, especially the pyramid of the second order (*s*), while the prismatic faces are short. It is very interesting to see how perfectly this crystal, from a new locality, conforms to this statement. It shows three very short and partly broken prismatic faces, and a large and perfect hexagonal pyramid of the second order; the basal plane is reduced to a small irregular face about one inch in its longest diameter, and bears several shallow pits or depressions, of which the inclined sides conform to the pyramid of the first order. Altogether, the specimen is one of unusual interest.

A. W. GRABAU, *Secretary.*

THE AMERICAN CHEMICAL SOCIETY. NEW YORK SECTION.

THE first regular meeting of this section was held on November 9 at the Chemists' Club, 108 W. 55th Street.

Professor A. A. Breneman, chairman of the section, presented his opening address, which was, in the main, an account of the history of organization among chemists in America, with remarks upon the present status of chemistry as a profession. He described the origin of the American Chemical Society and the Chemists' Club and urged the importance of maintaining a high standard of education among chemists.

Professor Winslow, of the biological department of the Massachusetts Institute of Technology, spoke 'On the Disposal of City Sewage.' Professor Winslow presented the prominent features of the development of sewage treatment in a clear and comprehensible manner, showing numerous slides to illustrate the various types of sewage plants. He indicated the research work now in progress at the Massachusetts Institute of Technology sewage experiment station and finally spoke of the latest developments in the purification of sewage, noting especially the trickling system.

The subject was supplemented by remarks from Professor Pellew on an interesting sewage problem in White Plains and by Dr. Soper, who spoke of the coming need of purifying sewage before dumping it into New York Bay.

C. M. Joyce,
Secretary.

DISCUSSION AND CORRESPONDENCE.

PRINCIPLES WHICH GOVERN THE UNITED STATES GEOLOGICAL SURVEY IN ITS RELATIONS WITH OTHER GEOLOGICAL SURVEYS AND WORKING GEOLOGISTS.

To the Editor of Science: Certain questions raised by the correspondence published by Professor Branner in Science for October 26 are, as he says, of general interest; and, in view of the manner in which they are there presented, require a statement of the principles which govern the United States Geological Survey in its relations with other geological surveys and working geologists.

There is among scientists in general a rule of courtesy that denies to others the privilege of investigation in a direction which one has made his own by reason of his contributions to knowledge along that line. The rule is variously construed in different countries and by different men, but it is no part of my purpose to minimize its force. It has been recognized by the national survey since the days of Director King, and is now effective in relations with individuals and state surveys. It is, however, necessarily controlled by the progress of the general survey and the development of general plans, which sometimes require that work shall be done by the national organization notwithstanding meritorious individual claims. Moreover, professional courtesy on the part of a public official is subject to limitations imposed by his obligation to Congress and to the people to render prompt and efficient service.

A long experience, including relations with nearly all the working geologists of the country, has clearly demonstrated that men whose first obligation is to a university can not work as efficiently for the national survey as can the geologists constantly in its employ, and recognition of this fact has led in recent years to a reduction of the proportional amount of work allotted to teachers of geology, who can give but a share of their time to it.

These considerations governed the national survey in the matter of the Arkansas coal fields. Not only professional courtesy but also personal regard prompted the offer of cooperation made to Dr. Branner under date of January 31, 1906, the purpose of which was to secure to him the publication of his results and the credit due him for his service to the state, as well as to avoid unnecessary duplication of field work. The obligation to execute the surveys with that promptness and efficiency which could follow only from undivided attention required that his desire to finish the work should be disregarded.

It appears from Dr. Branner's latest letter that he still regards the survey of a coal field worth many millions of dollars and capable of serving several millions of people as his personal affair. This bureau is directed on broader lines. He is led by his personal view of the question to misconstrue not only the correspondence which has passed, but also the administrative policy of the national sur-

vey. The insinuation that the proposal to pay for the Arkansas reports could have had an improper motive may be set aside as unworthy of his own standing and mine. But I deny his charge that the survey is an undemocratic organization which abuses its power to the disadvantage of state surveys or of individual geologists. It encourages the organization of state surveys and seeks to cooperate with them in all practicable ways. It endeavors to maintain cordial cooperative relations with all working and teaching geologists, and welcomes all practical suggestions which may lead to a closer touch with them. That its attitude in these relations is necessarily controlled by the obligations of a national bureau to the people has already been said.

The last quarter of a century has been one of extraordinary development in geology. The leaders in this progress have been members of the United States Survey, and by virtue of their services it has had a dominant influence in the development of methods and of knowledge. To serve on its staff, in whatever capacity he is qualified by experience to fill, is no discredit to any geologist, nor is it a reflection on any geologist, however able and honored, that the work which he did a decade or two ago should require revision and should be revised according to the latest standards of topographic and geologic skill by the specially trained members of the national survey's permanent staff.

CHARLES D. WALCOTT.

A NEW VARIETY OF HONORARY PH.D.

WHAT constitutes an acceptable thesis for a Ph.D. degree is a problem which at some time has engaged the attention probably of every department and surely of every graduate faculty in our real universities. Of course it matters little to those institutions which still continue, in defiance of the best opinion and practise both here and abroad to grant the degree *honoris causa* or as a reward for the completion of a set time or of a specific series of courses. But it was a matter of astonishment to learn that graduate schools with higher ideals are given to accepting as theses publications which have no evident relation to themselves, if indeed these papers reflect in any way the influence of the degree-granting institution. Within the past two years and at two different universities of good standing in the country, I have asked by chance what the work of a newly introduced doctor had been and was shown in each case a voluminous government document. Careful examination not only demonstrated that the publication was everywhere attributed to the direction and support of the particular division, the name of which appeared prominently printed on the cover and title pages, but also failed to disclose anywhere in the text the most obscure reference to the institution which had crowned the writer with the coveted laurel. Perhaps it is wrong to question the procedure, but the student had not been actually in residence for more than a brief period 'because you know,' the professor in charge naïvely remarked, 'he could not find the material or the literature for that work here, and then, too, the bureau paid all the expenses of the work.' One could not help wondering what part in the work the aforesaid professor had played when he had evidently not even assigned the topic for investigation.

But the climax appeared in a communication which one of my own colleagues received the other day. A long-time student and good friend of his had left his work for the doctorate partly finished to take a government position in the national capital, and after some time there wrote regarding his still unfinished thesis, "Unless some arrangements can be made by which the university will accept, as has been done in recent instances, and as is done by other universities, an official publication as fulfilling the thesis requirements, I shall have to abandon the plan of taking my degree from ———— and try another institution." The cordial relations existing between the two parties preclude any thought that an intellectual hold-up was attempted; it was merely the frank statement of the facts as the younger man in his official intercourse had found them. If the plan is recognized as feasible in official circles, as this and other circumstantial evidence would

serve to show is the case, then what of it from the university standpoint? No one would question that many government publications are abundantly worthy of the honor, but consider first the usually composite authorship which makes it exceedingly difficult to attribute to any single individual his due share of the work or to stamp it in any sense as research on his part; add to this the full financial and legal responsibility of the particular government bureau for the character and scope of this piece of investigation. Consider further the absolute lack of control on the part of the university over the correctness of the results reached, together with the omission of even its name from the text of the paper, and it is hard to say wherein this procedure differs from granting the degree purely *honoris causa*. After all, there are many men in actual work to-day who achieve results which *per se* would warrant granting them a doctorate. The best elements in university circles unite in agreeing that such a practise is dangerous, subversive of the best interests of graduate work and tending to break down the real university which we are now striving to build up in this country. This new tendency is equally disastrous and if seen in its true light is only another form of the ancient error against which university men should be on their guard. X.

AN INTERMITTENT FLOWING WELL.

Some months ago the city of Albany, Georgia, in order to get rid of an objectionable pond of water in the suburbs, attempted to drain it off underground by boring a well to a cavernous limestone, ninety or one hundred feet below the surface, when this rather singular phenomenon was discovered. Mr. Charles Tift, former city engineer, and a very accurate observer, gives the following description of the well:

A low place in the city requiring drainage and there being no natural outlet, it was decided to bore an eight-inch well to the cavernous limestone, by which method other ponds in the city had been drained. This special pond covered an area of about one half of an acre, the water having an average depth of eighteen inches. The well was bored at the edge of the pond, a small dam having been previously made to keep back the water. At the depth of ninety feet, the drill dropped some six or eight feet into a cavity. The drill was then withdrawn and the dam removed. The water at once began to run very rapidly into the well, not completely filling the bore hole, however. In six and one half minutes the well filled and the water began to bubble and almost immediately thereafter the entire column of water was ejected with considerable violence to an estimated height of about thirty feet. When the ejecting force spent itself, the water again commenced to flow into the well, and the same phenomenon was again repeated.

For about an hour the ejections continued, but with gradually decreasing violence and at longer intervals, but ceased entirely only when the static head of the water in the pond became greatly reduced. This well is said to repeat its geyser-like action whenever a heavy rainfall fills the pond.

S. W. McCallie.
Georgia School of Technology, Atlanta.

'THE WIRELESS TELEGRAPH AND AURORA.'

Some time ago I conceived the idea that the wireless telegraph might give assistance in unravelling the mystery of the aurora. The result was not exactly what I expected, and at the present time seems to add more complication to what was already complicated.

I have a record of observation by the wire on six nights during the last year, grouped in three, one and two, respectively, giving what are known as 'freak distances,' during spells of aurora, or the brilliant clear weather associated with aurora. During these three periods we received signals and read messages over abnormal ranges of 700 to 1,600 miles with an apparatus that ordinarily will not operate over more than 250 miles.

The apparatus could receive, but not send, and directly the aurora ceased or diminished, in at least four cases, the long distance messages also ceased to reach our wire.

My facilities are woefully inadequate, and I hope some weather service station with

wireless equipment, or one of the several wireless telegraph companies will take the matter up; for although it may not lead to a better understanding of aurora, it might help to the understanding of 'freak distances' over the wire.

C. J. STUART.

MONTREAL, October 29, 1906.

THE GLACIAL EPOCH.

TO THE EDITOR OF SCIENCE: While I much regret having overlooked the references to which Professor Chamberlin calls attention in the first few lines of his communication to SCIENCE (October 26, page 531), his further remarks (tending to demonstrate that Dr. Manson's theory is untenable), when considered in connection with the equally modern and equally reliable views of Professor E. W. Hilgard (as expressed in the last paragraph of his paper quoted on page 440 of this journal) afford an instructive illustration of how difficult it is, even for an able and conscientious investigator, to avoid dogmatism in science.

J. M. SCHAEBERLE.

ANN ARBOR,
October 29, 1906.

SPECIAL ARTICLES.

VARIATION IN PARTHENOGENETIC INSECTS.

IF, as the Neo-Darwinians claim, amphimixis is the principal cause of variation (of the continuous or fluctuating sort taken by Darwin and Weismann to be the material used by natural selection for species-building), it would seem to follow that much less variation, of this type, should occur among parthenogenetically produced individuals than occurs among individuals of bi-sexual parentage. The Neo-Darwinians explain variation as a product of sex and sex as a product of the necessity for variation.

The variation of bisexually produced individuals is proved by limitless miscellaneous observation and the more recent better compiled and expressed work of biometricians. But data and facts concerning the variation in parthenogenetically produced individuals are not so readily accessible. In the following paragraphs will be found a summary statement of the results of certain observations made by several assistants[1] and myself, on the variation exhibited in certain series of parthenogenetically produced insect individuals.

It is obvious that a comparison of the variation in agamically produced individuals with that of those of bi-sexual parentage *in the same species* would be particularly pertinent. And this we have been able to make in the case of the honey-bee. The variation[2] of various wing characters (dimensions of wings and vein-parts, modification of venation, number of costal hooks of hind-wing, etc.) has been studied in series of drones (parthenogenetically produced individuals) from queen-laid eggs (and also in series from worker-laid (!) eggs) and in series of workers, which are of bi-sexual parentage. Among these series are some (both of drones and of workers) in which the individuals were taken directly from the brood-cells (just as they were ready to issue) and hence before their exposure to any intraspecific (individual) selection on a basis of their adult characters (among which are all wing characters), and other series made up of actively flying, *i. e.*, exposed individuals. There are also series of drones hatched from worker-laid eggs and reared in worker cells (instead of in the usual larger drone cells), the variation in these series having a special interest because of the possibility of its modification by the extrinsic factor, size of cell. In addition to the bee series the variation in wing characters in a series of parthenogenetically produced female plant-lice (Aphididæ) has been studied. The studies are all statistical and quantitative and have been compiled, tabulated and summarized according to the now fairly familiar methods of biometric variation study. In this note only the baldest statement of results can be made, and their presumable significance suggested.

Variation in drone (parthenogenetically produced) and worker honey-bees (of bi-

[1] R. G. Bell, B. E. Wiltz, A. Wellman and F. Yantis.

[2] Some of these data of variation in the honey-bee have already been published by Kellogg and Bell, 'Studies of Variation in Insects,' *Proc. Wash. Acad. Sci.*, Vol. 6, pp. 203–332, 1904.

sexual parentage).—The honey-bee, *Apis mellifica,* is an insect with complete metamorphosis. The larvæ are footless, soft-bodied, white grubs which are born from eggs laid in cells, and which live for their whole life protected and cared for in the cells, those of any one community living under identical conditions of light and temperature and presumably of food and care. Even those of different communities have practically an identical environment. The larvæ pupate in the cells and the imaginal bees issue with wings, legs and numerous other structures wholly formed and in definitive character, and not corresponding to any functional larval parts. The variations, therefore, in the wings —to select structures particularly available for quantitative comparison, and wholly foreign to the larval body as functional parts, *i. e.,* parts capable of use or subject to disuse —must be looked on as variations as strictly congenital and independent of modifying extrinsic influences (*i. e.,* without trace of modifications acquired during development due to varying environment) as it is possible to find among animals. The wings, also, are structures possessed by all the three kinds of individuals composing the honey-bee species, and in all three kinds function identically, so that any variations the wings may exhibit can not be attributed to differences in the special function of the wings in the different kinds of individuals, but may be safely associated with the other general features in the make-up of each kind of individual, and be referred to as fair indicators of the kind and extent of variation characteristics of the different kinds of individuals.

The right and left fore and hind wings (removed and mounted on glass slides) of various lots of drones and workers were examined and measured for variations in (*a*) modifications of the normal (= modal) venation, consisting of the addition of vein spurs in 'slight,' 'fair' or 'marked' condition, and interpolated new incomplete or complete cells; (*b*) dimensions, as length and breadth of the whole wing, and length of vein-parts, these parts determined by the giving off of branches in the insertion of cross-veins; and (*c*) the number of grasping hooks along the costal margin of the hind wings.

The lots studied were: (1) a lot of 300 Italian drones taken from a laboratory hive, (2) a lot of 300 workers taken from same hive, (3) a lot of 48 Italian drones from a field hive, (4) a lot of 300 workers from this hive, (5) a lot of 100 German workers from another field hive, (6) a lot of 200 Italian drones from a field hive which were taken from their brood cells when just ready to issue, (7) a lot of 54 Italian workers from the laboratory hive taken from brood cells, (8) a lot of 25 Italian workers taken from cells and 50 workers acting as nurses (not yet having ventured from the hive) from a field hive, (9) a lot of 26 Italian drones from a field hive, taken from worker cells, (10) a lot of 200 drones from a queenless field hive (these drones hatched from worker-laid eggs and reared in worker cells), and (11) a lot of 60 Italian drones from worker eggs in worker cells taken from the cells at time of emergence. The lots of individuals taken from the brood cells just when ready to emerge (in fully formed imaginal condition with all wing-parts fully developed and in fixed definitive condition) were obtained for the purpose of ascertaining what difference, if any, exists in the amount of variation (in venation of wings) between bees exposed to the struggle for existence and bees not yet so exposed. If selection is really rigorous and intra-specific, that is, if varying individuals are preserved or extinguished on a basis of rigorous selecting among these variations, then one would expect that a series of individuals of any one species examined after exposure to this rigorous individual selection would show less variation than a series of individuals of the same species not yet exposed to this personal selection. The unexposed series should reveal the total amount of the variation characteristic of the species; the exposed series should reveal the amount of variation tolerated by a rigorous intra-specific selection. Also, as the workers in their constant going and coming outside the hive, carrying heavy loads of pollen, and ex-

posed to any danger which slow or imperfect flight might induce, as capture by birds and robber flies, may be fairly said to run much more risk in their life than the drones which make but a single brief daily flight (and that not every day), it might be thought or assumed that this strenuous life of the workers would tend to weed out by life-and-death selection every slight disadvantageous variation in the supporting skeleton (the venation) of the wings, all-important organs in this outside life. The series of drones reared in worker cells were obtained for the purpose of testing the assumption of Casteel and Phillipps (*Biol. Bull.*, V., 6, pp. 18–37, 1903) that extrinsic factors, depending on the shape and size of the brood cells, are of large importance in producing the drone variation. The series of drones hatched from worker eggs were obtained for the purpose of ascertaining the differences, if any, in the amount of variation exhibited by individuals normally parthenogenetically produced (from queen-laid eggs) and those abnormally parthenogenetically produced (from worker-laid eggs).

Now, the results of all this examination, mensuration and compilation (and this work, extending over several years, has been not inconsiderable) might be presented in a detailed way by curves and mathematical expressions, with, I hope, some special interest and profit to students of bionomics (which is evolution), but for the purposes of this note the baldest and most summary statements of them must suffice. These statements are the following: (*a*) In all but one of the characteristics studied, the amount of variation, both quantitative and qualitative, is markedly larger among the drone bees than among the workers, and in the one exceptional characteristic it is no less; (*b*) no more variation in wing characters is apparent among drones or workers that have not been exposed in imaginal condition to the rigors of personal selection than exists among bees, drones or workers, that have been so exposed; (*c*) the variation in wing characters in drone bees reared in worker cells is no greater than that among individuals reared in drone cells; (*d*) the variation among drones hatched from worker-laid eggs is markedly larger than that among drones hatched from queen-laid eggs (the drones of worker parentage are considerably smaller than those of queen parentage).

The significance of these results may be suggested to be: of result *a*, that the blastogenic variation among bees does not depend on amphimixis but is a result of some other factor; of result *b*, that the assumed rigorous intra-specific selection among slight continuous variations, which is a basic assumption in the natural-selection theory of species-forming, does not appear to exist in the case of honey-bees; of result *c*, that the larger variation of drone (parthenogenetically produced) bees compared with worker bees (of bi-sexual parentage) is not an ontogenetic phenomenon due to special extrinsic factors (size of cell) operative during development; and of result *d*, that the farther we get from amphimixis the greater we find the blastogenic variation to be!

I do not mean to insist too strongly on this last conclusion! There are two possible facts which may tend to invalidate it. One is that of the abnormality of parentage; the lack of practise, as it were, of the worker parents in the complex business of reproduction; the other is that our series of drones of queen parentage reared in worker cells is unfortunately too short to safeguard properly the conclusions derived from the study of the variation in it. While, as already stated as result *c*, the variation in this series showed no signs, except perhaps in one characteristic, of being proportionally larger than among drones reared in drone cells, a larger series might have revealed this possible larger variation. But the data of this short worker-cell series are typical of short-series data generally, and the marked lessening of the range in variation shown is quite in consonance with what should be found in a normal fractional part of a large series. However, it is well to accept result *c* with some reservation and hence to carry that reservation over to result *d*, inasmuch as the drones of worker parentage were all reared in worker cells. The actual fact, however, stated in result *c* is wholly true,

namely, that the drones of worker parentage show a much larger variation than those of queen parentage. Their coefficient of variation is from 50 per cent. to 75 per cent. greater. Also if results *d* and *c* are to be accepted with reservations, then so are the interpretations of their significance.

It may be said by some that the larger variation in the drones as compared with the variation in the workers may be due to the fact (?) that 'males vary more than females.' This generalization, which is one of Darwin's variation canons, has long been disproved as a general law. It is true in certain cases or classes of cases, these being mostly those in which the males possess certain secondary sexual characters of ornament and bizarrie, such as tufts, plumes, horns, processes, etc. The variation in such characters seems to be larger than in other body parts or at least this is generally believed to be true, although I do not now recall the detailed variation studies on which this belief is based, or should be based. But the characters chosen for study in the bees are precisely such as are not secondary sexual ones or special adaptations but are characters common in structure and use to both drones and workers. In other variation studies of exactly these characters, namely, characters of wing venation, in other kinds of insects, for example, the mosquito, we have not found the males to show a larger variation than the females. In these other cases both sexes are of bi-sexual parentage.

Variation in female aphids (parthenogenetically produced).—In the following paragraphs is presented a brief statement of the variation conditions found to exist in the venation of a series of parthenogenetically produced *female* insects. Unfortunately, the variation of these parthenogenetically produced females can not be compared with that in series of bi-sexual parentage of either sex in the same species, but, thanks to the methods of the biometricians, the mathematical expression of this variation (the coefficient of variation according to Pearson's formula) allows us to compare its extent with the variation of venation characteristics in other kinds of insects, male or female, of bi-sexual parentage.

In a series of 200 winged females of the mustard plant louse (species unknown), produced viviparously by agamic stem-mothers, and collected on the university campus, the variation in wing size, in dimensions of vein-parts, in modification of the venation (addition or loss of branches and cells, etc.) in fore and hind wings, and the number of grasping hooks on the hind wings were studied. In all these characters a notable variation is apparent. In modification of venation (addition or loss of branches, change of forking, interpolated cells and the like), 76 wings out of the 800 show notable variation. No biometric expression can, of course, be given for this substantive variation. For the meristic variation, however, in number of costal hooks, in length and breadth of wings, in length of various vein-parts (varying independently of the varying size of the wings) the coefficients of variation have been determined, and are notably large. For example, they are as large as the coefficients of the variation in similar wing-parts in mosquitoes,[3] ants and worker bees, in all of which amphimixis is the rule. We have not been able to compare the variation in parthenogenetically produced aphids with that in the early spring generation of stem-mothers that comes from eggs of bi-sexual parentage. Perhaps we shall be able to do this in another year. But what we have already before our eyes is sufficient to show us that variation actually exists among these parthenogenetic individuals in extent and character sufficient to serve natural selection as a species-building basis, if the familiar fluctuating, continuous or Darwinian variation ever is sufficient for this purpose. Amphimixis is not only not necessary in order to insure Darwinian variation, but there is no evidence (that I am aware of) to show that it increases this variation. There is, on the other hand, a little evidence, some of it pre-

[3] For determinations of variation conditions in these other insects see Kellogg and Bell, 'Studies of Variation in Insects,' *Proc. Wash. Acad. Sci.*, Vol. 6, pp. 203–332, 1904.

sented herewith, to show that such variation occurs, whether the offspring be of uni-parental or bi-parental ancestry, and to show that this variation is no greater in amphimixis than among parthenogenetically produced individuals. Yet Weismann's plausible assumption will probably long continue to hold its unproved own.

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A STATISTICAL STUDY OF AMERICAN MEN OF SCIENCE. II.

THE MEASUREMENT OF SCIENTIFIC MERIT.

MANY of the problems that the writer had in view in the present research might be solved by the study of any group of a thousand American men of science, so long as they had been objectively selected. The objective selection of a group sufficiently large for statistical treatment is, however, essential. As cases can be quoted to illustrate the cure of nearly every disease by almost any medicine, so examples can be given in support of any psychological or sociological theory. The method of anecdote, as used by Lombroso, may be readable literature, but it is not science. A thousand names might have been selected by lot from all the scientific men of the country, assuming a list to have been available, but a group of the thousand leading men of science arranged in the order of merit has certain advantages. Information in regard to them can be better obtained than in the case of those who are more obscure. Correlations can be determined between degrees of scientific merit and various conditions. The comparison with a similar group selected ten or twenty years hence, or with a similar group of British, French or German men of science, would give interesting results. The list itself, if printed after an interval of twenty years, would be a historical document of value. Lastly, the data can be so used as to carry quantitative methods a little way into a region that has hitherto been outside the range of exact science. It is the last problem that I wish to take up in this paper.

It will be remembered that we have in each science the workers in that science arranged in the supposed order of merit by ten competent judges, who made their arrangements independently. If the ten arrangements agreed exactly, we should have complete confidence in the result, except in so far as it was affected by systematic or constant errors. If there were no agreement at all, the futility of any attempt to estimate scientific merit would be made clear. The conditions are naturally intermediate. There is a certain amount of agreement and a certain amount of difference of opinion. Thus taking, for example, the ten astronomers—I., II., III., etc.—whose average positions were the highest, the order given to them by each of the ten observers, *A*, *B*, *C*, etc., is as shown in the table:

TABLE I. THE ORDER ASSIGNED TO TEN ASTRONOMERS BY TEN OBSERVERS.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
A	1	2	4	3	10	6	9	5	11	8
B	1	4	2	5	6	?	9	3	8	7
C	1	4	?	5	2	*16	6	17	7	*21
D	?	2	4	3	1	5	7	13	8	6
E	1	*9	2	5	6	3	8	4	7	11
F	1	4	10	2	5	6	3	7	8	11
G	1	3	5	*16	2	6	7	13	4	8
H	1	3	5	7	6	4	9	?	8	2
I	1	2	8	4	10	6	7	3	11	5
J	1	2	4	5	12	8	3	6	13	7
AV.	1.0	3.5	4.8	5.5	6.0	6.6	6.8	7.8	8.5	8.6
av.	1.0	2.9	4.8	4.3	6.0	5.5	6.8	7.8	8.5	7.2
m.v.	0.0	1.4	1.9	2.4	2.8	2.3	1.7	4.3	1.9	3.4
P.E.	0.0	.45	.59	.84	.84	.85	.48	1.15	.54	1.09
p.e.	0.0	.39	.57	.68	.79	.69	.48	1.28	.54	.96

Here we find complete agreement that I. is our leading astronomer. He has been selected as such by nine competent judges from the 160 astronomers of the country.[1] The probability that this is due to chance is entirely negligible. II. stands next in scientific merit. He is placed second by four of the observers, third by two, fourth by three and ninth by one. The conditions are similar to observations in the exact sciences. The average position or grade is 3.5, and the probable error of this position is 0.45, *i. e.*, the chances are even that this grade is correct within one half of a unit. The grade of the astronomer who stands third is 4.8, and that of the astronomer who stands fourth is 5.5. There is consequently one chance in about fifty that II. deserves a grade as low as that of III., and one in about one thousand that he deserves a grade as low as that of IV. The order thus has a high degree of validity, and this has itself been measured. As we go further down the list, the probable errors tend to increase, the order is less certain, and the difference in merit between a man and his neighbor on the list is less. The variations in the sizes of the probable errors are, as a rule, significant. When the error is small the work of the man is such that it can be judged with accuracy; when it is larger it is because the work is more difficult to estimate.

The probable errors depend on the assumption that the individual deviations follow the exponential law, and they do so in sufficient measure for the purposes in view. For those near the top of the list, the distribution of errors is 'skewed' in the negative direction, that is, there are relatively more large negative than positive errors. Thus in the table there are four judgments marked with a star, the deviation of each of which is more than three times the average deviation, and these observations would be omitted by an approximate application of Chauvenet's criterion. If these four observations are omitted, the grades of the ten astronomers are those given in the second line of averages. The omitted judgments are not extremely divergent, barely exceeding the limits set by Chauvenet's criterion, and I do not regard them as invalid. Indeed, I believe that in view of the presence of systematic errors in these estimates the chance that they represent correct values is greater than that assigned by a strict application of the theory of probabilities. But the incidence of an extreme judgment might in special cases do injustice to an individual, and in the order used Chauvenet's criterion has been applied.[2] This means that a compromise has been adopted between the median and the average judgment; but the departure from the average judgment is small, affecting less than one fifth of the individuals and only to a slight degree. The average deviations and probable errors used are those found when all the judgments are included. Two probable errors are given in the table, the first obtained through the error of mean square, the second by taking it as directly proportional to the average deviation. The differences are not significant, and for work of this character I regard it as useless to calculate the probable errors by the ordinary formula. I have published elsewhere[3] a more technical discussion of the treatment of errors or deviations of this character, and may return to the subject at some subsequent time. The theory of errors commonly applied in the exact sciences is too crude for psychology, and probably for the

[1] In three cases where a question mark appears the astronomer did not give a position to himself. In one case the name was not included among the slips.

[2] Among the some 15,000 observations under consideration several variations might be expected to occur in a normal distribution as much as six times as large as the probable error, and among the 1,500 or more individuals, several might be expected to deserve positions departing considerably from those assigned. But assuming that we have 'normal errors' to deal with, there is no reason why the particular individuals on whom the divergent errors fall should receive them rather than any other individuals. Such errors should apparently be distributed among all the individuals. Similar conditions must occur in the case of errors of observation in the exact sciences, but so far as I am aware their significance has not been considered.

[3] *Am. Journ. of Psychol.*, **14**: 312–328, 1903.

sciences in which it is used. Progress here will be blocked until there are psychologists who are mathematicians or mathematicians who are psychologists.

In order to illustrate further the serial distribution and the probable errors, I have made a diagram for the fifty psychologists. The grade of each, no judgments being omitted, is shown by the vertical mark, and the length of the line indicates the probable error or range within which the chances are even that the true position falls. Thus the psychologist who stands first on the list, was, like the astronomer, given this position by the independent judgment of all. The psychologist who stands second has, as shown on the diagram, a position of 3.7 and a probable error of 0.5, *i. e.*, the position 3.7 is the most probable, but the true position is equally likely to be within the short horizontal line, between 3.2 and 4.2, or outside it. It must, however, be remembered that the chances of the true position being far outside the range of this line decrease very rapidly. Over it is roughly drawn the bell-shaped curve of the normal probability integral. The true position is along the base line covered by this curve, and the chances of its being at any given point are proportional to the ordinate or height of the curve above the base line. There is only one chance in about six that the true grade is above 2.7 or below 4.7, and only one chance in about 150 that the true grade is above 1.7 or below 5.7. It will be seen from the diagram that while the positions of the psychologists II., III. and IV. are the most probable, the relative order is not determined with certainty. On the other hand, the chances are some 10,000 to one that each of these psychologists stands below I. and above V.

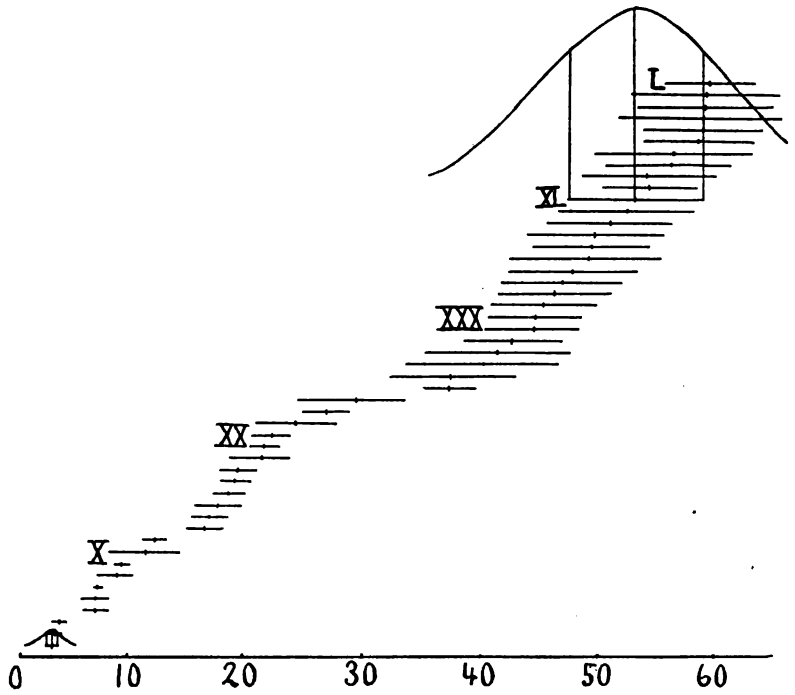

FIG. 1. The positions and probable errors of the fifty psychologists.

It is evident that the probable errors increase in size as we go down the list. The curve of distribution drawn over No. XL. indicates that the chances are even that the true

position falls between the grades of XXXIV. and L. and that there is one chance in four that he does not belong among our fifty leading psychologists. The increase in the size of the probable errors is irregular, it being more difficult to assign a position to some men than to others.

It will be noted that the psychologists fall into groups, the first twenty being set off from the next group, though the two groups are bridged over by three cases. At this point also the probable errors become almost suddenly about three times as large. There are altogether about 200 psychologists in the country, and it looks as if the first tenth forms a separate group of leaders. There is a similar, though less marked group of the first twenty astronomers, but these groups seem to be partly accidental. There is, however, as shown below, an inflection point in the curve of distribution after about the first tenth of our scientific men. The first twenty psychologists fall into four distinct groups, and there are groupings in the other sciences. They do not, however, appear to be sufficiently marked to lead us to distinguish species, such as men of genius and men of talent. It is, however, possible that the complicated conditions may ultimately be analyzed so as to give such groups.

The probable errors not only tell the accuracy with which the psychologists can be arranged in the order of merit, but they also measure the differences between them. This, indeed, I regard as the most important result of this paper, as science is advanced chiefly by the extension of quantitative methods, and it might not have been foreseen that it would be possible to measure degrees of scientific merit. Our data are concerned with the recognition of scientific performance, not with abstract ability, if such a thing is conceivable. Merit is in performance, not in non-performance, and expert judgment is the best, and in the last resort the only, criterion of performance.

The difference in scientific merit between any two of the psychologists whose positions and probable errors are shown in the chart is directly as the distance between them and inversely as their probable errors. If two of them are close together on the scale, and if the probable errors are large, the difference between them is small, and conversely.

If the psychologists II. and III. were separated by 0.5 and their probable errors were 0.5, as is approximately the case, then the difference between them is so small that there is one chance in four that the position of III. is above the grade of II. If again the psychologists XL. and XLIX. were separated by 6 and their probable errors were 6, as is approximately the case, then there is again one chance in four that the true position of XLIX. is above the grade of XL. The difference between II. and III. is thus about the same as that between XL. and XLIX.

If we take the fifty psychologists in groups of 10, and thus partly eliminate the chance variations, the average probable errors of the five groups are 0.7, 1.8, 4.2, 5.8, 6.2. These probable errors are subject to a correction for the range covered by the grades. Thus the first ten cover a range of about eleven points, and the last ten a range of about six points, and the differences between the psychologists at the top of the list would be nearly twice as great as between those at the bottom of the list if the probable errors were the same. When we take account of both factors, the probable errors in the five groups are 0.6, 1.9, 1.8, 6.4 and 10.7. While the probable errors are determined with a considerable degree of exactness, which is itself measured, the ranges covered by the grades seem to depend on the special conditions in the science; they are not the same in the different sciences, and their validity can not be determined with any exactness. Subject, however, to a considerable probable error, the range of merit covered by the fifty psychologists is inversely as the figures given, and reduced to a scale of 100 would be: 55.6, 17.5, 18.5, 5.2 and 3.2.

Thus we can say that the psychologists at the top of the list are likely to differ from each other about 18 times as much as the psychologists at the bottom of the list. We have no zero point from which we can measure psychological merit. Men who are 6 ft. 2 in. tall are likely to differ from each other

about ten times as much as men who are about 5 ft. 8 in. tall, though the difference in their height is only as 68:74. Even though we assumed the zero point to be where psychological performance begins or at the survival minimum of human ability, we should only obtain relative differences.

The astronomers and the psychologists have been used as illustrations. The number of students of astronomy and of psychology in the country does not differ greatly, and it is assumed that they represent an equal range of scientific merit. It is possible that it requires more ability to be an astronomer than to be a psychologist, and it is equally possible that, in view of the larger endowments, longer history and more conventional problems, less ability will suffice for the astronomer. The curves of distribution might also vary; for example, it might be relatively easier to be an astronomer of moderate performance, but more difficult to be a great astronomer. There are indications of such differences, but the data at hand do not disclose them with any degree of certainty.

There are 100 geologists and 100 botanists on the list, who are about one fourth of all the geologists and botanists of the country. These are assumed to cover about the same range of scientific merit as the astronomers or the psychologists. The average difference between the geologists would consequently be about half that between the astronomers, and the probable errors of position should theoretically be about twice as large. The anthropologists are the smallest class of scientific men, numbering in all about ninety, of whom 20 are included in the thousand under consideration. They are again assumed to cover a range of performance equal to that of the astronomers or geologists, the average difference between them being two and a half times as great as between the astronomers or five times as great as between the geologists. The chemists are the most numerous class of scientific men, 175 being included in the thousand. There are 150 physicists, 150 zoologists, 80 mathematicians, 60 pathologists, 40 physiologists and 25 anatomists.

In the accompanying table are given the

TABLE II. GRADES AND PROBABLE ERRORS OF THE TWENTY MEN OF SCIENCE WHO STAND FIRST IN EACH OF THE SCIENCES.

	Mathematics.		Physics.		Chemistry.		Astronomy.		Geology.		Botany.		Zoology.		Physiology.		Anatomy.		Pathology.		Anthropology.		Psychology.	
	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.
I.	2.5	.6	1.6	.7	3.6	.6	1.0	0	2.5	.4	2.9	.8	2.7	.2	2.0	.3	1.5	.3	1.0	0	1.7	.2	1.0	0
II.	3.3	3.0	3.2	2.5	4.4	.5	*2.9	.4	3.3	.4	3.3	.5	3.2	1.0	2.6	.3	*1.8	.2	3.9	.3	2.6	.2	3.0	.5
III.	3.7	.7	3.7	2.7	5.5	1.7	*4.3	.6	5.4	1.6	5.0	1.6	4.3	1.3	*4.3	.5	5.7	1.0	3.9	1.5	2.7	.3	3.2	.4
IV.	5.7	.5	9.0	.3	6.3	1.2	4.3	.5	7.0	2.2	6.7	1.1	4.6	.9	5.7	.5	6.6	1.3	4.3	.6	4.5	.4	4.4	.6
V.	5.7	1.6	9.6	7.9	3.3	1.5	5.5	.7	3.3	1.2	7.1	3.9	7.0	.9	6.1	.6	*6.7	.9	3.6	1.7	4.6	1.1	6.2	.9
VI.	*5.7	3.9	11.5	1.3	9.7	1.4	6.0	.3	11.3	1.9	7.5	.6	3.9	.9	6.2	1.1	7.0	1.2	11.1	1.5	7.2	1.0	7.1	1.2
VII.	9.2	1.0	*11.7	6.7	9.3	1.6	6.3	.4	12.2	1.5	8.1	2.6	12.6	5.2	7.5	1.1	8.0	1.2	12.0	2.7	8.4	.7	7.2	2.3
VIII.	9.6	3.6	11.3	2.1	11.4	1.7	7.2	1.0	17.1	2.3	8.5	.3	13.1	1.5	10.3	.3	*3.5	1.4	13.3	.7	3.5	.9	7.5	1.2
IX.	12.1	2.0	12.0	5.3	15.5	2.9	7.3	1.2	17.1	2.5	11.3	1.7	13.4	1.3	11.0	.9	*3.3	.3	14.3	5.6	10.4	1.6	3.0	.3
X.	13.1	1.5	12.2	1.7	15.3	1.5	3.0	.5	13.3	2.5	12.3	1.3	14.1	1.3	13.0	.3	*15.2	1.7	16.9	3.7	11.0	.3	9.5	.6
XI.	14.0	1.3	13.5	1.7	16.4	6.1	10.2	.3	19.3	4.5	13.2	1.3	17.3	5.0	15.2	1.7	*15.7	2.2	17.6	2.5	11.4	1.5	12.3	1.1
XII.	14.6	2.0	14.2	6.2	16.3	3.6	11.0	.3	19.4	3.7	13.7	1.9	17.6	5.2	15.7	2.2	*16.2	2.2	18.0	2.6	15.3	2.4	14.7	1.4
XIII.	14.7	3.1	14.3	3.0	17.3	3.7	13.6	1.1	19.4	4.6	14.3	1.3	*19.1	5.0	19.1	3.1	*16.4	1.5	18.5	4.1	17.5	1.3	17.1	1.5
XIV.	17.4	1.7	13.3	3.5	19.3	3.7	14.2	1.2	19.5	2.9	16.3	1.9	19.7	2.2	20.1	2.6	16.3	2.1	*20.6	2.2	13.0	1.2	17.9	2.3
XV.	19.1	3.4	19.4	4.3	20.7	1.5	14.3	.4	21.5	2.9	19.3	2.0	20.1	2.9	21.2	2.2	13.5	2.3	22.7	3.6	13.6	1.3	13.1	2.3
XVI.	21.5	2.3	19.5	2.2	21.3	3.4	17.0	.7	22.1	2.3	20.2	3.2	20.4	3.4	*21.3	2.7	13.6	2.3	25.5	2.7	19.1	1.6	13.7	1.5
XVII.	21.3	3.1	19.7	5.6	22.0	4.6	21.4	1.4	22.2	1.5	23.9	3.9	20.3	3.1	21.3	2.2	13.3	4.0	26.3	2.7	19.5	1.4	19.2	1.1
XVIII.	*22.3	2.6	21.1	2.3	24.7	2.5	22.7	1.2	*24.3	5.1	27.2	4.0	20.3	3.5	22.4	3.0	19.3	1.5	27.4	4.4	20.5	1.7	19.6	1.6
XIX.	23.1	2.9	21.2	3.7	25.3	6.4	22.9	3.0	26.5	3.5	27.9	3.2	23.0	3.2	24.4	3.0	21.1	1.9	27.5	4.5	21.3	1.5	20.0	3.4
XX.	23.3	2.6	22.1	4.9	25.4	12.7	23.3	2.6	*27.4	4.5	27.9	4.5	24.4	2.3	*25.4	3.7	22.7	3.7	29.9	4.0	22.0	3.6	20.4	1.3

grades and probable errors of the twenty men of science who were assigned positions at the head of each of the twelve sciences. All the anthropologists are thus included in the table, but only two fifths of the astronomers, one fifth of the geologists, etc. In cases in which an individual stands relatively higher in another science a star is attached.

It will be observed that the grades are, as a rule, lower than the positions. As has been stated, the distribution of the judgments or errors in the upper part of the list is 'skewed' in a negative direction, so that the average judgment is lower than the median judgment. Further down the list this tendency disappears, and towards the bottom, not given in the table except for the anatomists and anthropologists, the 'skew' is in the opposite direction. Chauvenet's criterion has been applied; it causes but an insignificant difference in the order, and for statistical purposes the extra calculations involved were superfluous. As has been explained, however, the incidence of a divergent judgment, which might be due to ignorance or prejudice, might be unjust to an individual. The probable errors have been obtained by taking them directly proportional to the average deviation and assuming that there were always ten judgments. In the comparatively few cases where there were less than ten judgments the probable errors of the average are too small, but the differences are not significant. In the measurement of scientific merit, we are concerned not with the probable error of the average, but with the average probable error, which does not depend on the number of cases. Figures for both might be given, but they are so nearly alike and so lacking in significance that it is not worth while.

As the table shows, there are in astronomy, pathology and psychology men who are placed distinctly at the head. In the other sciences those who stand first have grades varying from 1.6 to 3.6. In most cases the differences in grade are less than the probable errors, or not much larger, and the position is not determined to a single place, though it is determined with a theoretically high degree of validity within a very few places. Various groupings occur, which seem to represent the existing conditions of the sciences. Thus there are breaks of two or more units after chemists 4 and 8; physicist 2; zoologists 4 and 6; geologists 2, 5 and 7; botanist 8; mathematicians 3, 6 and 8; pathologists 1, 4, 5 and 9; psychologist 1; physiologists 7 and 9; anatomists 2 and 9, and anthropologist 5. On the other hand, there are cases in which consecutive numbers are bracketed or practically bracketed. Thus mathematicians 4, 5 and 6 have a grade of 5.7. These various groupings appear to be about what the probable errors would lead us to expect.

The probable errors tend to increase as we go down the lists, but with considerable irregularity. This irregularity is in part due to normal variability where the number of observations is small and the average deviations are relatively large, but the larger departures are usually significant, it being easier to assign a position to some men of science than to others. Thus, for example, it is not easy to compare a man who has made one or two important discoveries with a man who has accomplished a large mass of useful work.

The tendency of the probable errors to increase is, however, significant. It is easier to assign the order at the top of the list, and the difficulty increases as we go downward. This subjective fact is measured by the probable errors. It is in part due to less knowledge of those whose work is less important. I know of no way to eliminate this factor or to measure its influence. But the main factor is the real differences between the men, and these are assumed to be inversely as the probable errors and directly as the differences in grade.

In table III. are given all the probable errors averaged in six groups for each of the sciences. In the first and second groups are included one tenth of those in each science, and in the remaining groups one fifth. That is, the probable errors are divided into five equal groups, but the first group is divided into two subgroups, in view of the fact that the probable errors of the first tenth are distinctly smaller than those of the second tenth.

TABLE III. PROBABLE ERRORS IN EACH OF THE SCIENCES, THE MEN OF SCIENCE BEING DIVIDED INTO SIX GROUPS.

	Mathematics.	Physics.	Chemistry.	Astronomy.	Geology.	Botany.	Zoology.	Physiology.	Anatomy.	Pathology.	Anthropology.	Psychology.	Average.	P. E.
CRUDE PROBABLE ERRORS.														
I.	1.8	3.8	2.5	.4	1.7	1.6	2.4	.4	.4	.9	.2	.5		
	2.2	4.0	5.7	.8	3.5	2.7	4.1	.9	.9	3.0	.3	.9		
II.	4.1	8.5	6.9	1.3	5.2	4.8	6.8	2.0	1.3	3.7	.9	1.8		
III.	4.5	10.1	13.4	3.8	6.7	7.6	9.8	3.0	2.1	6.8	1.6	4.2		
IV.	6.0	9.4	15.0	3.6	7.0	8.7	9.6	2.9	2.7	5.9	1.6	5.8		
V.	6.4	8.5	13.9	3.2	6.7	8.3	9.6	2.9	3.4	6.0	2.0	6.2		
PROBABLE ERRORS CORRECTED FOR THE RANGE.														
I.	1.3	3.1	2.0	.4	.9	1.3	1.9	.3	.2	.5	.2	.4		
	1.8	2.8	3.4	.9	3.6	1.7	3.3	.7	1.7	2.8	.3	.9		
II.	3.0	6.2	5.0	.8	7.0	4.2	5.3	1.5	.8	3.3	.6	1.9		
III.	7.1	14.0	16.4	6.3	6.4	8.2	11.3	2.9	3.6	8.6	.9	1.8		
IV.	7.3	28.5	22.7	3.9	8.3	8.3	15.3	2.6	2.6	12.6	3.2	6.4		
V.	6.2	24.8	25.3	4.6	7.3	15.6	17.0	4.2	3.8	6.2	2.1	10.7		
THE SAME REDUCED TO A COMMON STANDARD FOR THE THOUSAND MEN OF SCIENCE.														
I.	16	21	11	8	9	13	13	8	8	8	10	8	**11.1**	.8
	22	19	19	18	36	17	22	18	68	47	15	18	**26.6**	2.9
II.	37	41	29	16	70	42	35	38	32	55	30	38	**38.6**	2.2
III.	89	93	94	126	64	82	75	73	144	143	45	36	**88.7**	6.4
IV.	91	190	129	78	83	83	102	65	104	210	160	128	**118.6**	9.1
V.	78	165	145	92	73	156	113	105	152	103	105	214	**125.1**	8.4

In the middle part of the table the probable errors have been adjusted to the ranges covered by each group, and in the lower part these figures have been reduced to a common standard of a thousand, so that the results for the different sciences may be comparable.

If the range of ability is the same in each science and if the difficulty of assigning the order in each science is the same, then the figures in the lower third of the table should tend to be the same in the different sciences. As the averages include from 2 to 35 cases, they are subject to a probable error which varies considerably. Thus, to take, for example, an intermediate case—the botanists—the probable errors of the six entries in the upper part of the table are: 0.25, 0.33, 0.18, 0.28, 0.22, 0.25. They thus seem to be determined with considerable validity. When the probable errors are adjusted for the ranges, a considerable 'chance' variation is introduced. If the figures were broken up into groups of different sizes, the results would be different. The figures in the last three groups of each of the sciences seem scarcely to be significant of real differences in the sciences, though they to a certain extent measure the actually existing conditions.

The figures in the table give the validity with which the positions are determined, and at the same time measure the relative differences between the men in the several groups. Thus the first tenth of the chemists have on the average their positions determined relatively to other chemists with a probable error of two places and the last fifth with a probable error of 25 places. In relation to the first hundred scientific men, a chemist in this group has his position determined on the average (apart from the error due to the interpolation) with a probable error of 11 places, whereas in relation to the last 200 scientific men, the place is determined with a probable error of 145 places.

The figures also show that the average differences between the chemists who are in the first tenth are about eight times as great as between the chemists towards the middle of the list and about twelve times as great as between the chemists towards the bottom of the list.

As has been stated, there are considerable variations in the figures for the different sciences. In general, however, those in the first hundred differ from each other about ten times as much as those in the last four hundred, among whom there are no constant differences. It is scarcely safe to draw inferences from the variations in the different groups and in the different sciences. If the probable errors in one science were consistently higher than in another, it would mean that in the former science it is more difficult to make the arrangement, which might be due to greater diversity in the work to be compared or to greater similarity in the men. The greater similarity in the men would probably be due to there having been relatively too many men included in that science. But such consistent differences do not appear. Thus the psychologists have the largest probable error in the last group, but the smallest in the third group, and the mathematicians have the second smallest probable error in the last group, but the second largest in the first group. In so far as these figures are significant, they might mean that our able psychologists are more able than our able mathematicians, whereas our lesser psychologists are less able than our lesser mathematicians. It is probably true that our leading psychologists would compare more favorably with those of Germany, France and Great Britain than our leading mathematicians, but inferences as to the variation in the distribution of ability in the different sciences can not be made from the data at hand with any considerable degree of validity. It would, however, be of interest to have comparable data for different nations and for different periods.

The workers in the twelve sciences have been combined into one series by interpolation, it being assumed that the range of ability in each science is the same. The probable errors have at the same time been increased to correspond with a thousand cases, as shown in table III. This makes the probable errors relatively correct, but does not allow for the additional chance variations caused by the interpolation. The list is of considerable interest, as it enables us to compare with more or less accuracy men of science working in diverse directions.

The order, grades and probable errors of the fifty who stand first are given to illustrate the method. We can thus say that the work of a certain physicist is equal in value to the work of a certain zoologist, or that a certain

TABLE IV. THE ORDER, THE SCIENCE, THE GRADE AND THE PROBABLE ERROR OF EACH OF THE FIRST FIFTY MEN OF SCIENCE ON THE LIST.

Order.	Science.	Grade.	P. E.	Order.	Science.	Grade.	P. E.	Order.	Science.	Grade.	P. E.
I.	Astron.	?	0	XVIII.	Chem.	38.8	6.9	XXXV.	Physiol.	65.0	7.0
II.	Path.	?	0	XIX.	Math.	41.3	37.1	XXXVI.	Psychol.	65.0	7.3
III.	Psychol.	?	0	XX.	Math.	46.3	8.7	XXXVII.	Path.	65.0	24.7
IV.	Physics.	10.7	4.8	XXI.	Zool.	46.7	6.0	XXXVIII.	Chem.	65.1	9.9
V.	Zool.	18.0	1.3	XXII.	Physiol.	50.0	7.7	XXXIX.	Bot.	67.8	10.6
VI.	Chem.	20.5	3.2	XXIII.	Bot.	50.0	15.9	XL.	Geol.	70.0	21.8
VII.	Zool.	21.3	6.9	XXIV.	Chem.	50.2	8.3	XLI.	Math.	71.3	5.9
VIII.	Physics.	21.3	18.2	XXV.	Geol.	54.4	16.2	XLII.	Math.	71.3	19.6
IX.	Geol.	25.0	4.7	XXVI.	Chem.	55.4	7.8	XLIII.	Bot.	71.3	39.2
X.	Chem.	25.1	2.4	XXVII.	Chem.	56.0	9.3	XLIV.	Bot.	75.5	6.2
XI.	Zool.	28.7	8.6	XXVIII.	Physics.	58.0	17.7	XLV.	Physics.	76.7	11.8
XII.	Bot.	29.0	8.1	XXIX.	Zool.	59.3	6.2	XLVI.	Physics.	78.7	14.2
XIII.	Zool.	30.7	5.9	XXX.	Physics.	60.0	5.2	XLVII.	Path.	80.0	10.7
XIV.	Math.	31.3	7.0	XXXI.	Psychol.	60.0	9.8	XLVIII.	Physics.	80.0	35.3
XV.	Chem.	31.4	9.8	XXXII.	Anat.	60.0	12.3	XLIX.	Bot.	81.1	27.2
XVI.	Bot.	33.0	5.3	XXXIII.	Physics.	64.0	53.4	L.	Physics.	81.3	11.2
XVII.	Geol.	33.3	4.7	XXXIV.	Path.	65.0	4.2				

chemist has one chance in four of being as competent as a certain pathologist, a result that would not be possible by direct comparison. The various factors which limit the exactness of the method should be kept in mind, but we have at least the beginning of a method which with further effort can be made more accurate. Similar methods can be applied to comparing the value of performance in fields even more diverse than the several sciences.

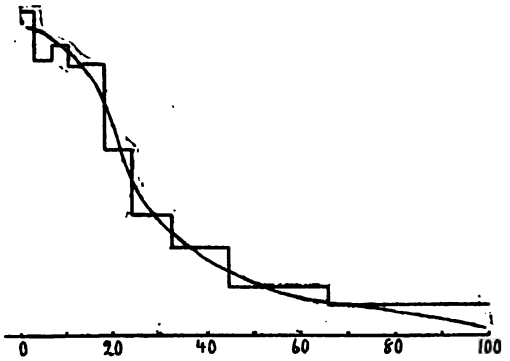

FIG. 2. Distribution of the thousand men of science.

In the accompanying curve—which is based on substantially the same figures as are given in table III., except that a man is given a position only in the science in which he stands the highest—is shown the distribution of the thousand men of science. The 1,000 scientific men are divided into ten groups, the range of eminence or merit covered by each hundred being proportional to the space it occupies on the axis of the abscissas, and the number of each degree of ability being proportional to the ordinates. The range of merit covered by each hundred becomes smaller and there are more of each degree of merit as we pass from the first to the second hundred and so on for the first five hundred, after which the differences become very small. The first hundred men of science cover a range of merit about equal to that of the second and third hundreds together, and this again is very nearly equal to the range covered by the remaining seven hundred. The average differences between the men in the first hundred are about twice as great as between the men in the second and third hundreds, and about seven times as great as between the men in the remaining groups. Or the differences among the first hundred are almost exactly ten times as great as among the last five hundred, who differ but little among themselves. It would be desirable to compare this distribution with that of the normal probability integral and with the salaries paid to scientific men, but the data are not as yet at hand.

J. MCKEEN CATTELL.
COLUMBIA UNIVERSITY.

NOTES ON ORGANIC CHEMISTRY.

OPTICALLY ACTIVE COMPOUNDS WHICH CONTAIN NO ASYMMETRIC ATOM.

OPTICAL activity, or the power of causing deviation in the path of a ray of polarized light, is shown by hundreds of organic compounds, all of which contain one or more asymmetric atoms of carbon, nitrogen, sulphur, etc. A carbon atom is asymmetric when it is linked to four, and a nitrogen atom when it is linked to five dissimilar atoms or groups. The only exception to the above connection of asymmetry and optical activity is the compound inosit, which has the formula

$$HOCH<\begin{matrix}CH(OH)CH(OH)\\CH(OH)CH(OH)\end{matrix}>CHOH$$

and is said to exist in two modifications of opposite activity. Quite recently a second exception has been discovered by W. Marckwald and R. Meth.[1] Their starting point is 1-methylcyclohexanone-(4),

$$(4)\qquad CH_2CH<\begin{matrix}CH_2CH_2\\CH_2CH_2\end{matrix}>CO,$$

from which, by a few simple steps, they obtain the corresponding acetic acid derivative. This is called 1-methylcyclohexylidene-(4)-acetic acid,

$$CH_2CH<\begin{matrix}CH_2CH_2\\CH_2CH_2\end{matrix}>C:CHCOOH.$$

By means of its chinchonine salts this acid is resolved into two new acids of opposite, and practically equal optical activity, just as is the

[1] *Ber. d. Chem. Ges.*, 39, 2404 (1906).

case with the corresponding tartaric acids, for example.

Should these observations be confirmed it can hardly fail to modify profoundly our conception of the spatial relations and stereochemistry of organic compounds. The authors believe that their new compounds are similar, spatially, to allene (isoallylene) derivatives of the type,

$$\overset{a}{\underset{b}{>}}c:c:c<\overset{c}{\underset{d}{}},$$

which might exist in two forms, each one of which would be the mirror image of the other, as was pointed out by Van't Hoff in his classical work on the spatial relations of the atom.

J. Bishop Tingle.

Johns Hopkins University,
October, 1906.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

The American Association for the Advancement of Science and the national scientific societies named below will meet in New York City during convocation week, beginning on December 27, 1906.

American Association for the Advancement of Science.—December 27–January 1. Retiring president, Professor C. M. Woodward, Washington University, St. Louis, Mo.; president-elect, Professor W. H. Welch, The Johns Hopkins University, Baltimore, Md.; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Dr. John F. Hayford, U. S. Coast and Geodetic Survey, Washington, D. C.; secretary of the council, President F. W. McNair, Houghton, Mich.

Local Executive Committee.—J. J. Stevenson, chairman, C. C. Adams, Charles Baskerville, Franz Boas, N. L. Britton, H. C. Bumpus, Chas. A. Conant, Simon Flexner, Wm. J. Gies, Wm. Hallock, Alex. C. Humphreys, G. S. Huntington, Edward Kasner, Henry F. Osborn, C. L. Poor, Clifford Richardson, E. B. Wilson, Frederick J. E. Woodbridge, J. McKeen Cattell, secretary.

Section A, Mathematics and Astronomy.—Vice-president, Professor Edward Kasner, Columbia University; secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor W. C. Sabine, Harvard University; secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Mr. Clifford Richardson, New York City; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Mr. W. R. Warner, Cleveland, O.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Dr. A. C. Lane, Lansing, Mich.; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Professor E. G. Conklin, University of Pennsylvania; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president Dr. D. T. MacDougal, Washington, D. C.; secretary, Professor F. E. Lloyd, Desert Botanical Laboratory, Tucson, Arizona.

Section H, Anthropology.—Vice-president, Professor Hugo Münsterberg, Harvard University; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Mr. Chas. A. Conant, New York City; secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Dr. Simon Flexner, The Rockefeller Institute for Medical Research; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

The American Society of Naturalists.—December 28. President, Professor William James, Harvard University; secretary, Professor W. E. Castle, Harvard University.

The Astronomical and Astrophysical Society of America.—December 28. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—President, Professor Carl Barus, Brown University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Mathematical Society.—December 28, 29. President, Professor W. F. Osgood, Harvard University; secretary, Professor F. N. Cole, Columbia University.

The American Chemical Society.—December 27–January 2. President, Professor W. F. Hillebrand, U. S. Geological Survey; secretary, Dr. William A. Noyes, the Bureau of Standards, Washington, D. C.

The Geological Society of America.—December 26–29. Acting president, Professor W. M. Davis, Harvard University; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

The Association of American Geographers.—December 31–January 1. President, Cyrus C. Adams, New York City; secretary, Albert P. Brigham, Colgate University.

The American Society of Zoologists.—December 27, 28, 29. President (Eastern Branch), Professor W. E. Castle, Harvard University; secretary, Professor H. S. Pratt, Haverford College. President (Central Branch), Professor C. C. Nutting, University of Iowa; secretary, Professor T. G. See, University of Michigan.

The Association of Economic Entomologists.—President, A. H. Kirkland, Malden, Mass.; secretary, A. F. Burgess, Columbus, O.

The Society of American Bacteriologists.—President, Dr. E. F. Smith, U. S. Department of Agriculture; secretary, Professor S. C. Prescott, Massachusetts Institute of Technology.

The American Physiological Society.—December 27, 28, 29. President, Professor W. H. Howell, the Johns Hopkins University; secretary, Professor Lafayette B. Mendel, 18 Trumbull St., New Haven, Conn.

The Association of American Anatomists.—December, 27, 28, 29. Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

The Botanical Society of America.—December 27, 28, 29. President, Dr. F. S. Earle; secretary, Dr. William Trelease, Missouri Botanical Garden, St. Louis, Mo.

The American Psychological Association.—December 27–28. President, Professor James R. Angell, University of Chicago; secretary, Professor Wm. Harper Davis, Lehigh University.

The American Philosophical Association.—December 27–29. President, Professor William James, Harvard University; secretary, Professor John Grier Hibben, Princeton University.

The American Anthropological Association.—December 27–January 3. President, Professor F. W. Putnam, Harvard University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—December 27–January 3. President, Dr. A. L. Kroeber, University of California; secretary, W. W. Newell, Cambridge, Mass.

New York State Science Teachers Association.—December 26, 27. Secretary, John F. Woodhull, Teachers College, Columbia University.

SCIENTIFIC NOTES AND NEWS.

A MEETING to commemorate the life and services of Samuel Pierpont Langley, secretary of the Smithsonian Institution from 1887 to 1906, will be held in the lecture room of the United States National Museum on Monday evening, December 3, at 8:15 o'clock. The following addresses will be delivered: 'Introductory Remarks,' by the chancellor of the Smithsonian Institution, the Honorable Melville W. Fuller, Chief Justice of the United States; 'Memorial on Behalf of the Board of Regents,' by the Honorable Andrew D. White, LL.D.; 'Mr. Langley's Contributions to Astronomy and Astrophysics,' by Professor E. C. Pickering, director of the Harvard College Observatory; 'Mr. Langley's Contributions to Aerodynamics,' by Octave Chanute, Esq., of Chicago.

THE Alumni Association of New York University has planned a testimonial to Professor J. J. Stevenson on the completion of thirty-five years of service as professor of geology in the university. A dinner will be given in his honor on December 7 at the Hotel Astor, and a silver loving cup will be presented to him.

THE formal presentation of the new portrait of President James B. Angell, of the University of Michigan, will take place on Saturday afternoon, December 8, in University Hall, Ann Arbor. This painting, which is by William M. Chase, of New York, is the gift to the university of the students, faculty and alumni. The picture will be presented to the university by Professor Henry M. Bates, of the law department, on behalf of all the thousands of donors, while the formal acceptance will be made by Regent Loyal E. Knappen. A formal address will also be delivered on that occasion by Professor Jeremiah W. Jenks, of Cornell University, an alumnus of the university.

SIR VICTOR HORSLEY, who has been connected with University College, London, as a student and as a teacher for thirty years, has resigned his professorship of clinical surgery and his position as surgeon to the hospital on account of increasing public and private professional duties. The council, in accepting his resignation, adopted unanimously the following resolution: "That the council, having received with great regret Sir Victor Horsley's resignation of his professorship of clinical surgery and his position of surgeon to University College Hospital, whereby his offi-

cial connection with the college is severed, desire to put on record their recognition of his long service to the college and the distinction he has conferred upon it by his eminence as a scientific investigator."

According to *Nature*, the honors conferred by King Edward on the occasion of his sixty-fifth birthday appear to be mainly for political services, and there is little recognition of the claims of science. Mr. John Tweedy, president of the Royal College of Physicians, has received the honor of knighthood; Colonel R. C. Hellard, director-general of the Ordnance Survey, and Mr. F. G. Ogilvie, principal assistant secretary (Technology and Higher Education in Science and Art) Board of Education, have been appointed Companions of the Order of the Bath; Colonel D. A. Johnston, formerly drector-general of the Ordnance Survey, has been appointed a Knight Commander of the Order of Saint Michael and Saint George; Professor R. W. Boyce, F.R.S., has received the honor of knighthood; and Dr. J. M. Lang, vice-chancellor and principal of the University of Aberdeen, has been appointed a Commander of the Royal Victorian Order.

Dr. William Osler, of Oxford University, will sail for America on November 28, to visit Toronto, Baltimore and other cities.

Dr. W. A. Kellerman, of the Ohio State University, will shortly make his third collecting trip to Guatemala for the purpose of collecting parasitic fungi, returning next March or April. He will be accompanied by two student assistants, and will be glad to execute any minor commissions of specialists so far as possible.

Dr. Mel. T. Cook, who recently resigned his position as chief of the department of plant pathology of the Central Agricultural Experiment Station of Cuba, expects to devote several months to studies at the New York Botanical Garden.

Dr. J. C. W. Frazer, of the Johns Hopkins University, has been appointed head of the research department of the United States Fuel-testing Plant, temporarily located at St. Louis, Mo.

Dr. E. B. Copeland, who has been connected with the government laboratories at Manila, has been elected horticulturist of the West Virginia station and will enter on his work about the middle of November. He is a graduate of Leland Stanford University, and previous to going to Manila was instructor in botany in this university.

Dr. J. K. Small, of the New York Botanical Garden, left for Southern Florida, on October 23, accompanied by Mr. J. J. Carter. Dr. Small will continue his investigations of the flora of this region.

Dr. W. Morris Travers, F.R.S., late professor of chemistry at Bristol University College, left Marseilles, on November 2, in the mail steamer *Victoria*, for Bangalore, to take up his work as first director of the Indian Institute of Science, to which he has been appointed by Mr. Morley, on the recommendation of the Royal Society.

The Gedge prize of Cambridge University has been awarded to Patrick Playfair Laidlaw, B.A., of St. John's College, for his essay entitled, 'Some Observations on Blood Pigments.'

Dr. E. A. Minchin, professor of protozoology in the University of London, delivered his inaugural address at the university on November 15. The subject was 'The Scope and Problems of Protozoology.'

Dr. William H. Chandler, emeritus professor of chemistry at Lehigh University, died on November 23, aged sixty-five years.

There will be a civil service examination on December 12–13, to fill a vacancy in the position of miscellaneous piecework computer in the Naval Observatory. The department states that miscellaneous computers are paid by the hour, and earn from $800 to $1,000 per annum. An examination will also be held for the position of forest assistant in the Forest Service at a salary of $900 a year.

The nineteenth annual meeting of the Geological Society of America will be held in New York City on December 26–29. The opening session on Wednesday will take place at Columbia University, Schermerhorn Hall, and will be called to order at 2 o'clock P.M.,

by Acting-President Davis. There will be no session on Thursday, the opening day of the American Association for the Advancement of Science, unless the council decides otherwise. The sessions of Friday and Saturday will be held at the American Museum of Natural History, 77th Street and Central Park, West. The customary dinner will probably occur on Friday evening, December 28. Under the rule securing rotation of subjects the order of papers at this meeting will be as follows: physiographic, cartographic, economic, physical and structural, glacial, stratigraphic, areal, paleontologic, petrographic. The meeting of the Cordilleran Section will be held on December 28 and 29, at Stanford University, California.

THE American Breeders' Association will hold its regular winter meeting at Columbus, Ohio, January 15–18, 1907. The sessions will be held at the university and board of trade buildings.

THE annual public meeting of the Academic Chambers composing the Institute of France was held on October 25, under the presidency of M. Gedhardt, who, after an allusion to the members of the institute who had died since the last meeting, announced that the linguistic prize had been won by Professor Jespersen, of the University of Copenhagen, for a treatise on comparative philology.

THE foundation-stone of the new German National Museum at Munich was laid by the German Emperor on November 13, in the presence of a distinguished and representative company.

THE collection of shells of British Mollusca, comprising about 5,600 specimens, belonging to the late Mr. Richard Rimmer, has been presented to the natural history department of the Royal Scottish Museum, Edinburgh.

THE Carnegie Museum has acquired by purchase a fine skull, with the horn-cores and horns ensheathing them, of *Bison crassicornis* Richardson. It was found in gold-bearing gravel at the bottom of a mine on Sulphur Creek forty miles east of Dawson. Associated with it were the remains of a mammoth. It is probably the most perfect specimen representing this huge creature which has thus far been discovered.

THE fire which recently occurred at the Carnegie Institute in Pittsburg was confined to the new engine-room, and the only damage done was to the great switchboard which runs along the north wall of the room. The splendid collections of the institute were never for one moment in any danger, as the building is practically fireproof. The damage consisted in the charring and burning of the insulation of the wires on the switchboard, which had not yet been taken over from the firm which had contracted for the installation. The origin of the fire is a mystery, as there was no current on any of the wires and there could have been no crossed wires. The loss will amount to a heavy sum, but the delay in completing the electrical equipment of the building which must result is a still more serious matter.

THE paleontological expedition of the Carnegie Museum to northwestern Wyoming, undertaken during the past summer under the direction of Mr. Roy L. Moodie, fellow in paleontology of the University of Chicago, assisted by Mr. E. B. Bartholow of the University of Kansas, has secured what is perhaps the best collection of plesiosaurian and amphicœlian crocodile remains ever brought together in any American museum. The beds explored were the Hailey shales of the upper Benton Cretaceous, described by Professor Williston in SCIENCE for October 20, 1905, and the explorations were made under his advice. The material collected, weighing more than five tons, includes two nearly complete skeletons, with excellent skulls, of plesiosaurs, one of the *Trinacromerum* type, the other of a broad-headed, short-necked form; about twenty-five other specimens of plesiosaurs, representing most parts of the skeleton; several specimens of hollow-boned amphicœlian crocodiles, probably either *Teleorhinus* or *Hyposaurus*, one of them a nearly complete skeleton with skull; a number of excellent turtles having well ossified carapaces and plastrons, perhaps allied to *Toxochelys*, and doubtless new to science; a small reptilian skull a few inches in length, of undetermined

relationships; and some fish remains. This material when worked out will add very materially to our knowledge of the marine Cretaceous fauna, and especially to our knowledge of the plesiosaurs of America.

YALE UNIVERSITY has appropriated a sum sufficient to cover the cost of publishing in book form the Mathematical Society's colloquium in New Haven last September. This is to be issued as a Yale publication. Copies will be forwarded to all subscribing members of the society and the remainder of the edition will be placed at the disposal of the librarian of the university for exchange and other purposes.

WITH the view of bringing together the cattle and most of the deer in the London Zoological Gardens the authorities have constructed a range of buildings in the south garden, between the lion-house and the pheasantries. The former deer-sheds have been improved and others built at the eastern end, the latter being furnished with paddocks corresponding to those of the older structure. South of this, but under the same roof, the new cattle-sheds have been put up, and the land cleared by pulling down the old ones has been thrown into the five large paddocks.

UNIVERSITY AND EDUCATIONAL NEWS.

PRESIDENT JOHN E. GOUCHER, of the Woman's College, Baltimore, Md., has deeded to the college his private residence for use as an administration building.

AN anonymous gift of $50,000 has been received by Yale University to establish the John Slade Ely professorship in the medical school in memory of Professor Ely, who died in the spring.

A NEW science hall at the University of Mississippi is in process of construction. This will be a large three-story building, and it is hoped that it will be completed in time for the geological and other collections to be transferred next summer. Other buildings under construction are a hospital and four residences for professors.

THE annual meeting of the trustees of the Carnegie Foundation for the Advancement of Teaching was held at the offices of the foundation in New York on November 20. The executive officers of the foundation are Dr. Henry S. Pritchett, president, and T. Morris Carnegie, treasurer, while the general officers of the board itself are: *Chairman,* President Eliot; *vice-chairman,* President Jordan; *secretary,* President Thwing.

WE learn from the *Harvard Bulletin* that the Harvard Graduate School of Applied Science, which was established last spring, begins its work this fall with an enrolment of thirty students. Courses are offered leading to degrees in the following subjects: civil engineering, mechanical engineering, electrical engineering, mining, metallurgy, architecture, landscape architecture, forestry, physics, chemistry, zoology, geology. The school will differ from the Lawrence Scientific School in that a bachelor's degree will be required for admission, and original work will be done, as is true of the Graduate School, in relation to the department of arts and sciences. The new institution will give to Harvard students five-year courses in both departments, the first three in each case being undergraduate.

THE resignation of Professor James Lee Love as secretary of the Lawrence Scientific School of Harvard University was received and accepted, to take effect November 12, 1906.

THE establishment of a chair of economic geology in the Sheffield Scientific School of Yale University is announced, with the appointment of Professor John Duer Irving, professor of geology at Lehigh University, as the first incumbent; Dr. G. R. Wieland has been appointed lecturer in paleobotany.

DR. HERBERT J. WEBBER, director of plant-breeding investigations in the Department of Agriculture, has been appointed professor of plant biology in the College of Agriculture of Cornell University.

THE council of King's College, London, has appointed Mr. Arthur Whitfield, M.D., professor of dermatology.

SCIENCE

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FRIDAY, DECEMBER 7, 1906.

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THE BUDAPEST CONFERENCE OF THE INTERNATIONAL GEODETIC ASSOCIATION.

THIS account of the recent meeting of the International Geodetic Association is necessarily unbalanced and incomplete. It must be brief. The formal minutes of the meeting were not available for use while preparing the report. It is not easy for one to appreciate fully all that occurs in a meeting in which the proceedings are carried on in three languages. Nevertheless, it is believed that a prompt report, calling attention to some of the more important features of the meeting will be of value, even if the report has defects.

The Fifteenth General Conference of the International Geodetic Association was held at Budapest, September 20–28, 1906. Such conferences of the association are, in general, held at intervals of three years.

There were present 61 delegates, representing 18 nations. Nearly every part of Europe was represented, as well as Japan, Mexico, the United States and Argentina. Argentina was represented in the association for the first time at this meeting.

The United States was represented by the undersigned.

The activities of the conference may conveniently be grouped in four classes and such grouping is favorable to a clear understanding of the purpose and effect of the conference. The activities were: (1) The presentation by the representatives of the different countries of reports of the progress in geodetic operations during the

past three years in those countries; (2) the presentation of special papers bearing upon improvements in instruments, methods of observation and methods of computation; (3) the transaction of the business of the association itself at the conference, in connection with the continuous operation of the central bureau maintained at Potsdam and in connection with the field work being done by the association as an organization; and (4) the social features of the meeting.

Through this and similar conferences a close and effective cooperation of many men of many nations, acting as an association, is secured in a certain few lines of research. Of these the greatest now being carried forward is an investigation of the variation of latitude.

Aside from this cooperation, all the activities of the conference served to make it a clearing house for ideas, a place where each may learn what ideas, old or new, are being acted upon in geodetic work in other countries than his own. In this process the social functions play an important part in bringing men together and helping them really to understand each other.

The association, as such, does not fix the methods of observation or computation in any country. It controls only the methods used in its own central bureau and in the field work paid for from the association funds. But, by virtue of the active interchange of ideas which takes place at the conferences, the association undoubtedly exerts a strong influence in making the methods used in various countries much more uniform and progressive than they otherwise would be.

The reports of progress within the past three years which were submitted show that the rates of progress in accumulating new results are very different in different countries, depending upon a great variety of conditions. Each country brought some contribution and the total represents a rapid increase in the mass of geodetic facts available for future use. It would be tiresome to summarize these reports here and the summaries would be of little value. Three items are, however, of special interest. Progress has been made within the last three years in the observations and computations connected with an arc in Spitzbergen and in connection with the remeasurement of the classical Peruvian arc, extended. Progress has also been made in South Africa on the measurement of an arc which is expected, ultimately, to extend from the Cape of Good Hope to the northern part of Russia, a total length of 104°.

Let us turn now to the special papers bearing upon improvements in instruments, methods of observation and methods of computation.

Th. Albrecht, of Germany, presented a report on a thorough investigation made at and near Potsdam, of the applicability of wireless telegraphy to the accurate determination of differences of longitude. The transmission time was found to be extremely small and sensibly independent of the particular receiver used and of the intensity of the sending.

Though not a delegate to the conference, Ch. Ed. Guillaume, of the International Bureau of Weights and Measures, by special invitation occupied the greater part of one session in presenting the results of the many tests of the Invar (nickel-steel) wires made at the International Bureau, describing the apparatus devised there for the rapid measurement of bases with Invar wires, and in giving a general statement in regard to the use of this apparatus in the measurement of a base extending the entire length of the recently completed Simplon tunnel. The extensive investigations of the International Bureau

show that the changes in length to which the Invar wires are subject are so small, and that the Invar wires have such physical properties, that they are suitable for the measurement of primary bases. The experience in the Simplon tunnel confirms this conclusion. The base apparatus there used is elaborate in comparison with that now in use in the United States for the measurement of primary bases with steel and Invar tapes. It also differs radically from the Coast and Geodetic Survey (U. S.) apparatus in having the entire measurement carried forward on movable tripods, just as measurements with base bars are made, instead of being carried forward on stakes driven in the ground, as are the tape measurements in the United States. The Simplon tunnel base was 20 kilometers long. The tunnel was placed entirely at the disposition of the measuring party for five consecutive days, no trains being run during that time. The measurement was made continuously in each direction through the tunnel, the party working in shifts of eight hours, day and night. The forward measurement was made in 59 hours. The remeasurement was made, after a day of rest, in 27 hours. The total number of persons employed on the measurement at any one time was 28. Seventy-seven different persons in all were involved in the measurement. This performance and its results leave no doubt that the necessary accuracy can be secured more quickly and conveniently with Invar wires than with any bar apparatus. Any one who will carefully compare this work, in all respects, with what has been accomplished with steel and nickel-steel tapes in the United States, on primary base work, will also be convinced that all the advantages claimed for wires may also be claimed for tapes, and that the use of tapes, rather than of wires, and of stakes, rather than of tripods, makes the measurement much more rapid, economical and convenient, and that the tapes are more reliable, as to length, than the wires.

Baron Eötvös, of the University of Budapest, occupied the greater part of one session in presenting a discussion of the results secured by him with certain torsion balances of special design. A similar presentation may be found in *Wiedemann's Annalen,* 1896, and another in the report of the Congrès International de Physique, Paris, 1900. He evidently aroused much interest. The conference visited his laboratory in a body to see the apparatus. He derives from the observations the first differentials of gravity with respect to distance measured along the three rectangular axes at the point of observation. From these observed quantities may be derived various other quantities, such as, for example, the radii of curvature of the geoid at the point of observation. The claims made as to the simplicity of the manipulation of the apparatus, the accuracy of the results, and the certainty with which the positions of the excesses and defects of mass within the earth may be determined by such observations, are astonishing. If the validity of these claims is established by future investigations, these torsion balances will become very important as being the most powerful means available for determining the distribution of density within the earth.

Dr. O. Hecker exhibited the very interesting apparatus which has been used by him, under the direction of the association, for determining the value of gravity at sea. He presented the results of recent observations made with this apparatus on the Pacific on two voyages between Sidney, Australia, and San Francisco, and between San Francisco and Yokohama. The atmospheric pressure is determined in terms of millimeters of mercury by a mercurial

barometer and simultaneously the pressure is also determined in absolute units by an accurate observation of the boiling point of water, using mercurial thermometers. From these simultaneous observations the intensity of gravity at the point of observation is computed. This method is entirely successful in determining gravity with the accuracy necessary for an effective study of the anomalies in gravity. This is the only successful method yet devised for determining gravity at sea with sufficient accuracy. Such observations are of extreme importance to geodesy, because they are the only geodetic measurements possible over three fourths of the globe. Hecker's observations show that, in general, over the deep Pacific gravity has nearly its normal value, as computed by Helmert's formula of 1901, fixing the relation between gravity and latitude. Parenthetically, it may be remarked that this indicates that the condition called isostasy exists. Four regions with large anomalies, with reference to Helmert's formula, were found. Near Oahu, one of the Sandwich Islands, gravity is considerably in excess at sea, just as it has already been observed to be on the island. There is a region of excessive gravity in shallow water near New Zealand. Over the submerged Tonga plateau, where the depth is 3,000 meters, gravity is largely in excess and in the adjacent Tonga deep (5,000–10,000 meters) there is a large defect of gravity.

H. Kimura, of Japan, reported on a harmonic analysis of the variation of latitude which has been made by him. The analysis develops the very interesting fact that in addition to its other motions, already approximately known, the pole has a reciprocating motion approximately along a straight line, with a period of about 0.75 year, a period which is not commensurable with any of the other known periods of the polar motion.

Lallemand, of France, for many years the authority on precise leveling, stated that a series of experimental comparisons had been made in France between the French instrument and method and the instrument and method used in the U. S. Coast and Geodetic Survey since 1900. The conclusion reached was that the degree of accuracy is sensibly the same in the two cases, because in each the instrumental errors have been made so small that the errors in the results are mainly due to meteorological conditions, that is to conditions between the object glass and the rod.

On the part of our own country there was presented a special report upon a recent determination of the figure of the earth, made by the Coast and Geodetic Survey and based entirely upon deflections of the vertical observed in the United States. This report showed that to secure the highest degree of accuracy in such determinations the theory of isostasy must be taken into account; that the United States is not maintained in its position above sea level by the rigidity of the earth but is, in the main, buoyed up, floated, because it is composed of material of deficient density; and that the defect of density is limited to the depth of 71 miles, if it is uniformly distributed with respect to depth. This report, if it is convincing, must ultimately produce radical changes in the methods of computation used by geodesists. It also has a direct bearing upon several of the greater problems of geology and of geo-physics.

The activity of the association itself, as distinguished from the activities represented by reports of progress and special papers, is indicated by the fact that the average rate of expenditure for the past three years has been $19,000 per annum. This covers administration, printing and postage, the maintenance of the central

bureau and such field work as is paid for by the association.

The principal work of the central bureau, under the direction of Dr. F. R. Helmert, may be summarized as follows:

Relative gravity determinations in various countries have been furthered by special examinations in detail of apparatus to be used for this purpose and by instructing the observers.

Professor Borrass has been occupied in studying the existing relative gravity determinations with a view to their proper combination in a gravity net extending over the globe.

A systematic study of deviations of the vertical in Europe has been continued by Professor Börsch, and progress has been made in the publication of the results.

A systematic study by Dr. Helmert of the curvature of the geoid along certain meridians and parallels, in countries where there is extended triangulation, has been nearly completed.

The determination by Dr. Kühnen and Dr. Furtwängler of the absolute value of gravity at Potsdam which has been in progress for several years has been completed and the final results are now being printed. In these determinations, five different pendulums have been used at Potsdam and a very extensive series of observations have been made with great care. It was found that the general experience of the past was repeated and that systematic differences, much too large to be accounted for as errors of observation, were found between the results from different pendulums. In trying to account for the large residual furnished by one of the five pendulums, which was of peculiar form, the suspicion arose that possibly the stem of this pendulum was subject to flexure, as the pendulum took various positions during each swing. Accordingly, a mathematical theory of such a possible flexure was developed fully for the first time. The effect of the flexure upon the value of gravity given by each of the five pendulums was then computed, using this mathematical theory which expresses the effect in terms of the modulus of elasticity of the material composing the stem, the dimensions of the stem, and the masses of different portions of the pendulum. The corrections brought the results into closer agreement. The same theory was, with similar success, applied to six other series of pendulum observations made at various times and at places connected with Potsdam by accurate relative determinations of gravity. In these series, pendulums of various designs have been used. The adopted value of gravity at Potsdam is a simple mean of the seven values, one of these being the value observed at Potsdam. The adopted mean differs by one part in 25,000 from the Potsdam determination. Helmert states that he believes the possible error of the adopted mean to be less than one part in 100,000. The total range of the seven values is one part in 33,000.

Two of the seven values depend upon observations made with the Bessel ball and wire pendulums. For these the complete theory developed by Bessel for taking account of the flexure of the wire was used without modification.

The gravity determinations at sea by Dr. Hecker, already referred to, were made under the direction of the central bureau and paid for by the association.

The principal field work, supported by the association, is the determination of the latitude variation. For the latitude observations and the necessary computations of them, made at the central bureau, the expenditure has been, on an average, $14,000 per year, during the past three years, more than two thirds of the total expenditure of the association. From 1899 to date, observations have been made continuously at

six stations, all in latitude 39° 08′ north, and surrounding the pole. In 1906, two stations in the southern hemisphere were established, in Argentina and in Australia. The observations at all of these eight stations will be continued at least until 1909. The accuracy with which the motion of the pole is followed by these observations may be inferred from the fact that Kimura writes with confidence that the movement having a period of 0.75 year exists, though its total amplitude is apparently 0.06″ (6 feet) or less.

By a formal resolution, transmitted to it in advance of this meeting, the association was asked by the International Association of Academies in what way it could sustain or promote international cooperation in the following two matters: (*A*) Leveling of precision in chains of mountains subject to earthquake, with a view of determining whether such chains are subject to changes in elevation; (*B*) measurements of the value of gravity for the purpose of throwing light upon the internal distribution of terrestrial masses and upon the rigidity or isostasy of the crust of the earth. This resolution is the result of action taken at the International Geological Congress, held in Vienna in 1903.

A special report on that part of the resolution which refers to leveling was, by request, prepared in advance by Lallemand of France. He set forth the rather discouraging past experience in this line and indicated the essential difficulties of the problem. He reported that determinations of the stability of the ground by means of precise leveling, repeated at long intervals, should be made in all regions, not simply in chains of mountains subject to earthquakes; that ordinarily a general change of elevation of less than one decimeter can not be detected with certainty; and that each country should repeat the leveling, over at least the principal lines of its precise level net, two or three times in each century.

Darwin, of England, prepared in advance, by request, a report on that portion of the resolution which refers to gravity determinations. He suggested a resolution in reply to the effect that the association welcomes the resolution transmitted to it as showing that geodetic observations throw light on the science of geology, and that the association further desires to impress on geodesists who may be planning future gravity observations that it is desirable that the sites for observation should be chosen with reference to such use of the observations.

The recommendations made by Messrs. Lallemand and Darwin were incorporated in a resolution passed by the association. At the suggestion of Darwin the resolution, as passed, also definitely recognized that observations of the direction of gravity, that is of deflections of the vertical, may also be used in determining the isostasy or rigidity of the crust of the earth, as well as observations of the intensity of gravity.

Nearly all of the party lived at the same hotel. Numerous social functions also kept the party together and served to make the delegates acquainted with each other. Among the social functions were a reception by the Archduke Josef, at the Royal Palace, a dinner given by the city of Budapest, a dinner given by Count Apponyi, the Minister of Public Instruction, an informal dinner given by the delegates in honor of their entertainers, an evening of Hungarian opera and several afternoon excursions.

The surroundings in which the conference met were especially interesting. It is a surprise to find that Budapest, the Hungarian capital, is a rapidly growing modern city, with all modern improve-

ments. One finds in it an intense national life and, at the same time, many interesting evidences of the influence of several different civilizations. Eleven different languages are officially recognized by being printed upon the paper money.

O. H. TITTMANN,
JOHN F. HAYFORD.

SCIENTIFIC BOOKS.

Mars and its Mystery. By EDWARD L. MORSE. Boston, Little, Brown and Company. 8vo. Pp. 192.

This book is distinctly a plea for the existence of intelligent inhabitants upon our sister planet, the argument being based largely on the observations of Professor Lowell at Flagstaff, Arizona. The author begins by pointing out that because a man is an astronomer, this fact by no means qualifies him to act as a judge upon a question of this sort. It is doubtless true that astronomers as a rule know little of the appearance of the surface of Mars, and but few of them have ever seen it under favorable conditions. Nevertheless, it must be admitted that a man who is familiar with the difficulties of telescopic observations, under varying atmospheric conditions, would be a better judge of the value of telescopic evidence than one who had never looked through a telescope, and took it for granted that the planet looked exactly as it is drawn on paper.

A large part of the book is devoted to an examination of the views of various astronomers and amateurs as to the interpretation of the various markings seen upon the planet's surface. The book is marred in one or two places by a rather savage personal attack upon a British astronomer in good standing, partly, apparently, on account of his religious convictions! Considerable attention is paid to the appearance of various systems of natural cracks, such as appear in pottery, dried mud, and the surface of the moon. Two interesting plates are given, in which these are compared with maps of railway systems, canals, and the markings upon Mars. The argument is drawn that the last look, and are distributed, much more like the artificial than like the natural lines. Whether such is the case or not, the critic will be likely to ask "But would the markings on Mars, if we could see them well, really resemble the drawings that Professor Morse publishes of them?" This is the very *crux* of the whole question, and until this has been definitely decided, most astronomers will consider the existence there of intelligent inhabitants as unproved, although perhaps not impossible.

The main and generally accepted facts relating to the planet's surface are briefly stated, and are followed by an interesting and rather amusing account of the author's own difficulties in seeing even the well-known and most clearly defined markings of the planet. He certainly had much more difficulty than would have been expected, considering the careful training of his eye in his own professional work.

One of the most interesting chapters of the book is that devoted to the discussion of the variety of conditions under which life exists upon the earth. Here our author is more nearly on his own ground, and states a number of interesting facts, many of which it is safe to say will be new to the majority of his readers. From them he argues that the slightly dissimilar physical conditions that exist upon Mars would not interfere with the existence there of life in some of its various forms, such as we know it upon the earth.

In closing, it may be said that the book is interesting, and well worth reading to all those who wish to learn the opinions of various authorities on the most fascinating of all the planets.

WILLIAM H. PICKERING.
HARVARD COLLEGE OBSERVATORY.

First Course in Zoology. A text-book for secondary schools, normal schools and colleges. By THOMAS WALTON GALLOWAY, Ph.D., Professor of Biology in James Millikin University. P. Blakiston's Son and Company.

This book adds another to the list of text-books in zoology, of an elementary nature, which have appeared within the past half dozen years, and is indicative of the growth

of interest in the subject among educators. Unlike most of this number, the present book purports to be adapted to either secondary school, normal school or college grade. In one respect this is a point worthy of consideration, in that it seems to recognize the correct pedagogical principle of the essentially similar aims and methods of the elementary course, whether in school or in college. On the other hand, it involves the difficult problem of furnishing a course of instruction, suited in character and extent to students of the varying capacity and training of the second or third year of the high school and the corresponding second or third year of the normal school or college, the periods in which such course is likely to have its place. The task is not, perhaps, impossible, but confessedly difficult; and to the reviewer's thought the present book has not clearly solved the problem.

For the average school course the book includes too much, and too difficult work; while for the college course it seems to fall as far short. For the normal school, and this is probably the grade of work more directly aimed at by the author, the book would seem to be well suited.

In method of arrangement the book follows rather closely the well-known 'Lehrbuch der Zoologie' of Hertwig, best known to American teachers of zoology through Kingsley's translation under the title 'Manual of Zoology.' That is, there are two parts to the book. (I.) General Principles; (II.) Special Zoology. Under the first part is a series of chapters dealing with protoplasm, the cell, the tissues, physiology, adaptation, etc. Under the second part is taken up a review of the entire animal kingdom, from protozoa to mammals. That there are elements of value in this method of presentation will not be questioned. That they are of the fundamental and supreme importance assumed by their authors is not so clear. To the writer the method has always seemed open to serious objections. For example, to begin such a course with the study of the morphology and physiology of protoplasm, followed by an attempt to clear up the intricacies of cell morphology, including the details of cleavage, chromosomes, centrosomes, spiremes, with prophase, metaphase, etc. (cf. pp. 22–35), reverses one of the fundamental canons of sound pedagogy, long since pointed out by Huxley, and now generally recognized by most teachers of zoology.

A similar criticism holds with reference to the chapters devoted to tissues, promorphology, and adaptations. To formulate these points in advance, outline the problems of evolution, etc., and rally about them the various data involved in their solution, is again to reverse the inductive order, presenting first that which ought to form the climax and conclusion of the course, thus depriving the student of the privilege of coordinating the facts as they develop. The chapters on general animal functions and something of tissues are, perhaps, very appropriate, though it has always been the method of the reviewer to develop these points as they arise in the progress of the course. And to devote fully one third of the entire book to such a preliminary study seems altogether disproportionate. Indeed, this course seems to include something of two ideals, namely, *biology* as distinguished from *zoology*, or in other words including two courses under a single caption.

In another respect the book is open to some criticism. The author postulates for the elementary course in zoology a four-fold purpose, viz., '(1) laboratory work, chiefly physiological, and in the larger problems of morphology rather than in minute dissection; (2) to field observation on physiology, life histories, the simpler problems of distribution and life relations; (3) to the body of the descriptive text, and (4) to classes of questions demanding reference to classical zoological authorities.' To each of these phases he would give an equal apportionment of time. It may be doubted whether for elementary pupils this would not prove impracticable, especially reference to such 'classical authorities' as Darwin, Wallace, Davenport's 'Experimental Morphology,' Lloyd Morgan's 'Animal Life,' Eimer's 'Evolution,' etc.

Of actual errors in statement of facts or principles there seem to be relatively few. In speaking of the larval life of echinoderms the author refers to them as 'free-swimming—

pelagic—' etc., seeming to use the terms as synonymous. Again, there is something of doubt in the validity of certain references to symbiotic relations, as in the following: '*Hydractinia* and even the sea-anemone form interesting partnerships with the hermit-crab.' This is all admirable and beyond dispute. But that 'the polyps cover up the shell occupied by the crab, thus concealing it from its enemies and its prey' may be seriously doubted. Indeed, every observer knows that there are more hermit-crabs without the hydroid colonies than with them. And furthermore, the reviewer has found larger colonies of this particular hydroid on bits of water-logged spars and on the piles of a dock than the combined colonies of scores of crab-shells.

The figures are for the most part well selected and executed. In a few cases figures are rather too diagrammatic for accuracy. In its mechanical aspects the book is a creditable piece of press-work. The typography is excellent and mistakes few. A slight one may be noted in the description of Fig. 68, where the expanded and contracted vorticellæ are wrongly indexed. C. W. H.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for October contains but two papers: 'The Naididæ of Cedar Point,' by L. B. Walton, and the 'Mechanism of the Odontophoral Apparatus in *Sycotopus canaliculatus*,' by J. C. Herrick. The microscopic Oligochæta have received little attention in this country and Professor Watson's paper deals with the local species systematically, giving a key to the genera and describing seven new species. Professor Herrick describes in detail the structure and workings of the rasping apparatus by means of which the winkle bores through and destroys so many clams and similar mollusks. He decides that Huxley's views were correct and that the radular membrane bearing the teeth slides back and forth over the supporting cartilage like a chainsaw.

The Bulletin of the College of Charleston Museum for October is mostly devoted to the early history of the museum which may possibly claim to be the oldest public museum of natural history in the United States. The rival claimant is the collection of minerals of Harvard which dates back to 1798.

The Museum News of the Brooklyn Institute for November has articles on the 'Housekeeping of a Large Museum,' 'The King Penguin' and on 'The Woodward Jade Collection.' This last contains a good *résumé* on the history of jade objects and the methods of working. The principal article in the Children's Museum section is devoted to 'Bird Life in Bedford Park.'

SOCIETIES AND ACADEMIES.

THE TORREY BOTANICAL CLUB.

ON May 23, 1906, the club held a special meeting in commemoration of the tenth anniversary of the commencement of work in the development of the New York Botanical Garden.

The meeting was held in the lecture hall of the Museum Building at the Botanical Garden. President Rusby presided, and there was an attendance of 125. The following persons were elected to membership: Percy L. Ricker, U. S. Department of Agriculture, Washington, D. C.; Miss Winifred J. Robinson, Vassar College, Poughkeepsie, N. Y.; Miss Bina Seymour, 115 West 84th Street, New York City.

After the election of new members the club listened to an illustrated lecture by its president on 'The History of Botany in New York City.'

Dr. Rusby presented a historical sketch of the development of botany in the city of New York, giving special attention to the history of local botanical gardens, of the botanical department of Columbia College and of the Torrey Botanical Club. The earliest local work related to the botanical gardens of Colden, Michaux and Hosack, and to the publication of local catalogues and floras. The second period was that of text-books, manuals and other educational works. Out of the associations resulting from local work, the Torrey Botanical Club developed so gradually that it was impossible to fix the date of its

actual beginning. Portraits of its early members were exhibited and brief biographical sketches presented. Out of the activity of the club and of the botanical department of Columbia, grew the demand for a great botanical garden, which was satisfied by the establishment of the present New York Botanical Garden. The contemporary botanical forces at work in the city were briefly described, and their most important present needs outlined. The complete address was published in *Torreya* for June and July, and separates will be furnished at ten cents each.

The lecture was followed by an informal reception in the library, and by an inspection of the library, laboratories, herbaria and the museum exhibits.

C. Stuart Gager,
Secretary.

Discussion and Correspondence.

The Policy of the U. S. Geological Survey and its Bearing upon Science and Education.

To the Editor of Science: It is but fair to Director Walcott that his reply to my letter insisting upon my resignation should be laid before those who have seen the earlier letters. The following is a copy of it:

U. S. Geological Survey,
Washington, D. C., Nov. 9, 1906.

Dr. J. C. Branner,
Stanford University, California.

Dear Sir: Your letter of October 13 was received at this office on October 22, and in my absence was acknowledged by Dr. Hayes on October 23. I was naturally surprised on my return to find that this letter, together with other correspondence on the subject of surveys in the Arkansas coal field, had been published in Science on October 26. I am at a loss to understand your reasons for publishing the correspondence, inasmuch as I do not think anything is to be gained by a public controversy. I have sent a brief communication to Science (copy enclosed) explaining the principles which govern the United States Geological Survey in its relations with other geological surveys and working geologists.

In your letter, on page 2, you state seven reasons, deduced from my letter of March 8, for the course followed in this matter, and reply to them. Permit me to add a word of comment to your replies.

1. "The field work on the Arkansas coal region was done 18 years ago." You recognize that work done so long ago needs to be brought up to date before publication. Your contention is that, "having originated and directed the survey of the Arkansas coal fields," you should be allowed to bring the work and the report up to date. This, of course, is the gist of the whole matter, and I shall revert to it again.

2. "It was based upon poor maps." There is no difference of opinion on this point. Inasmuch, however, as the scale of publication proposed by this Survey is only half that insisted upon by yourself, and as the map will be published without contours, the defects in the topographic base are very much less serious than they would have been if your proposition had been accepted and an attempt had been made to publish maps on the 62,500 scale.

3. "The work is not 'up to present standards' and therefore could not be accepted for publication by the Survey." You state that "neither you nor any of your assistants have read the report and you can not therefore know anything about its relations to standards of any kind." While the report has not been read, you will recall that the maps were examined in December, 1901, by Dr. Hayes in connection with the proposition to publish the report at that time. These maps bore such evidence of inaccuracy and generalization that the scale proposed for their publication was not regarded as suitable and the recommendation was made that they should be reduced, preferably to one-quarter, and at least to one-half, the scale proposed. He made no statement regarding the standard of the written report, but considered the maps as amply justifying the statements made regarding the character of the work. You will recall that in the correspondence of 1901, when the proposition to publish your report was being considered, an essential condition to such publication was that additional field work should

be done by some member of this survey, Messrs. Taff and Adams being mentioned in this connection. You are mistaken, therefore, in supposing that there was any intention on the part of this survey to accept your report without thorough examination and additional field work.

4. "New uses for the coals have been found by the fuel testing plant of the survey." This has little bearing on the subject except that it increases the urgency for information regarding this coal field.

5. "Losses have been caused by errors in the map of the Arkansas coal field for which I am responsible." This is based upon very definite and emphatic statements made by large coal operators in the Arkansas field. They have stated that on the basis of the map published in the twenty-second annual extensive holdings were transferred from one region to another and on testing it was discovered that productive had been exchanged for unproductive territory. It was on account of the representations of these coal operators, and their urgent requests, that the work was undertaken in Arkansas, and not through the recommendation of any member of Congress.

6. "The salaries of regular assistants of the survey being provided for, work must be given them." Three geologists whose salaries had been provided for to the end of the year had completed their office work and were available for field assignment. If the money asked for the payment of yourself and assistants for the Arkansas work had been allotted, it would have been impossible to send these men into the field and they would practically have remained idle until the new appropriations became available.

7. You say "I was anxious to obtain your unpublished data, for which ample payment would have been made and full credit given." In reply to this you say "the reports of the Arkansas Geological Survey not being my personal property, I leave others to characterize your proposition to pay me for one of them." You imply in this statement that something dishonorable was contemplated in the transaction. I must remind you that on July 9, 1901, a check for $200 was sent to you in payment for a report on the clays of Arkansas, which presumably was as much the property of the state as the coal report. It was distinctly stated at that time that this payment was "for the necessary office work required to put your reports into shape for publication." The "adequate payment" for your coal report would have been for precisely the same purpose. If you had felt that you were not entitled to the payment, it would have been a simple matter to turn it over to the state of Arkansas.

As distinctly stated, I desired to obtain your report in order, first, that the results of your work might not be entirely wasted, and, second, that you might receive the credit to which you would have been justly entitled. However inadequate a report on the geology of a region may be, and whatever errors it may contain, it is of some benefit to another geologist who is taking up the study of the region, and I considered that a reasonable expenditure would be justified because of the benefit your report would be to a geologist entering the field.

I am quite willing to accept your statement of the seven reasons for my action which you have deduced from my letter of March 8. These reasons are all good and were regarded as fully justifying the course pursued. You are correct further in your conclusion that there are other reasons which it was not considered necessary to state in my former letters. In that correspondence I ought, perhaps, to have been less careful of your feelings. The additional reasons which had weight in the matter are as follows:

1. It was extremely desirable that the report on the Arkansas coal field should be issued at the earliest date possible. This was made a point of special urgency in the requests received from those most directly interested in the field. In order to secure this result it was deemed essential that the work should be done by regular members of the survey, who should bring their results to Washington and work them up here. I need only refer to the experience of the survey with your own reports to indicate the grounds for fearing that if the work were turned over to you prompt-

ness in publication would be impossible. The clay report above mentioned was paid for on July 9, 1901. The manuscript was received, after several urgent requests, at the end of March, 1904. The manuscript for the Santa Cruz folio was promised for July, 1903. It was received March 17, 1906.

2. An examination of your preliminary coal report published by the Arkansas Survey, together with the map furnished Mr. Taff for publication in the Twenty-second Annual, in the light of subsequent work on the coal measures in the region immediately adjacent in Indian Territory, led the geologists familiar with the matter to the conclusion that you had made serious errors in correlation and in the interpretation of structure in the Arkansas field. It was believed that these errors might very easily be perpetuated if the resurvey of the field should be made by yourself—that you would be handicapped by your belief in the correctness of your former conclusions, and hence that better results would be secured if the work were done by some one entirely free from preconceptions as to stratigraphy and structure.

3. During the last ten years much attention has been paid by this survey to the examination of coal fields in various parts of the country. A body of experts has been developed whose experience is probably not anywhere surpassed. On the other hand, so far as I am aware, you have, since leaving Arkansas, devoted little if any attention to the investigation of coal fields; also those whom you would probably secure for assistants in the work, with the possible exception of Dr. Newsom, would have had little if any experience in this kind of work. In this age of specialization it will, I think be conceded by all that even the examination of a coal field can be done more efficiently by coal experts than by those whose training has been in other lines of geology.

Concerning the last three pages of your letter I shall make very brief comment. The relations of this survey with existing state surveys are uniformly cordial. Every effort is made to strengthen state surveys and to cooperate with them in such a way as to render their usually limited resources most productive of good to the people of the state. Cooperation is never forced upon a state organization, and extreme care is exercised to prevent duplication by this survey of any work being carried on by any state organization. As to the invasion of fields occupied by professors of geology, there are in the files of the survey many letters to such professors urging them to work up the local geology and offering financial assistance and means of publication of their results. The case of the Fayetteville quadrangle is perhaps an apparent exception. It should be stated, however, that when the work was undertaken there Professor Purdue was practically unknown as a geologist and was, as a matter of fact, not sufficiently experienced to carry on independent work. Since his season with Adams he has been employed each summer and has submitted three folios for publication. It has been necessary, however, in connection with this work, to send more experienced men into the field with him, although he will receive the entire credit for the work.

The right of any geologist to restrict the field of operations of this survey in opposition to the public interests can not be admitted. Where work is being done by a private geologist or an institution or an organization, or where the work has been done, and there is prospect that the results will be published, it is manifestly contrary to good policy for another organization to enter the field and do the same work over again. The survey has scrupulously refrained from such invasion of an already occupied field. The fact that a field has been occupied does not, however, give exclusive rights to the first occupant indefinitely if there is no prospect that the results will ever be published. Eighteen years is sufficient time in which to secure publication of results, and in this case the interests of the public far outweigh any private interests you may have retained in the field.

Your letter of February 26, 1906, tendering your resignation as geologist in the United States Geological Survey has been forwarded

to the Secretary of the Interior with recommendation that the same be accepted.

Very respectfully,
CHAS. D. WALCOTT,
Director.

Some of the points mentioned in this and in the letter to the editor of SCIENCE, especially those relating to maps, scales, qualifications, errors both topographic and geologic, may be left to one side as being of little importance in this connection, though I should not hesitate for a moment to submit my own case on every count mentioned to any jury of scientific men. It is quite evident to any unbiased geologist that the reasons put forward for the survey's invading my field are mere subterfuges for an inexcusable course of conduct.

It is worth while, however, to note certain points in passing. Mr. Walcott does 'not think anything is to be gained by a public controversy.' Perhaps not; but it is certain that nothing is to be gained by an appeal to courtesy or by a private controversy with a public bureau that has the whip-hand of every working geologist in this country. And neither is anything to be gained by a cringing submission to such a bureau. This is a matter of public concern, and so long as one gets no hearing in private he has no remedy but to bring the subject to the attention of the public.

To the charge of making mistakes my reply is that I have made them and do make them.

Mr. Walcott says: "It appears from Dr. Branner's latest letter that he still regards the survey of a coal field worth many millions of dollars and capable of serving several millions of people as his own personal affair. This bureau is directed on broader lines." This is merely a bit of political dust, and the broad lines on which he directs the survey do not appear to preclude the use of such materials. I regard the work on the area concerned as my own personal affair just so far as the work done on it entitled me to finish it and no further.

Leaving these minor matters, attention is asked to four propositions that vitally concern scientific work and scientific education in this country as affected by the attitude of the U. S. Geological Survey toward state surveys and towards the geologists of the country not regularly employed on the survey.

First, it is maintained that the U. S. Geological Survey can and does encroach upon fields that, by the rules of equity and common courtesy, belong to state surveys and to local individual workers in geology.

Mr. Walcott meets the first proposition squarely in his letter to me. The italics are mine. He says: "*The relations of this survey with existing state surveys are uniformly cordial.* * * * *Cooperation is never forced upon a state organization, and extreme care is exercised to prevent duplication by this survey of any work being carried on by any state organization.*" Near the end of his letter to me he says: "*The survey has scrupulously refrained from such invasion of an already occupied field.*"

My own experience as state geologist of Arkansas is far from bearing out these statements; but as the survey of which I had charge is no longer in existence, and as he seems to wish to confine the question to those that have not yet been killed, let us take one that has managed to survive. One of the state geologists writes me under date of October 29, 1906, as follows: "*My own experience officially has been as bitter and wholly unjustifiable as yours.* By repeated and vigorous personal appeal * * * and only by resort to * * * our representatives in congress have I been able to save this * * * state survey from a most humiliating exigency. Indeed I have not wholly succeeded, and am grimly conscious to-day that though I have dislodged the U. S. Geological Survey corps from most all parts of the state, *its representatives have held on to one region where we were busily engaged at the time of their arrival, and ignoring entirely all our work, have carried their humiliating procedure to a finish.* We have spent some thousands of dollars in correcting the unskilful and erroneous work of these gentry. * * * To tell our experience would be a long story, perhaps bootless to rehearse, but I join with you and many others

in deprecating the present policy of the survey in the matter of intrusion upon states to the great discredit of the state organizations and the individual geologists."

And this Mr. Walcott calls 'uniformly cordial' relations, 'strengthening and cooperating with the state surveys,' and 'scrupulously refraining from invasion of an already occupied field'!

But whether the relations of the state surveys to the national survey are cordial or not (and I am far from doubting that *some of the state surveys know that unless they keep up the appearance of cordiality they will soon cease to exist*), I assert, without the slightest fear of successful contradiction, that there is not a single state geologist in this country to-day who does not know that his work, his field of operations, his livelihood, and his very reputation are wholly at the mercy of the national survey. And I ask any person who has the blood of a free man in his veins if this is not an intolerable state of affairs.

Mr. Walcott says that 'cooperation is never forced' on a state survey. I beg to refresh his memory with the fact that when a bill providing for a state geological survey was lately before a certain state legislature, he himself wrote to prominent members of the legislature advising that unless cooperation with the U. S. Geological Survey was provided for, the bill should not pass. If that is not forcing cooperation on a state then I fail to understand the English language.

So far as individuals are concerned the survey seldom takes them into consideration save when they do something or turn up something that is likely to serve the purposes of the survey. If the individual undertakes any special bit of work, whether in field or laboratory, the survey is in position to invade his territory, to drive him out of it, and to discredit him. Is it not a most humiliating fact that scientific men, in this the twentieth century, should be compelled by a federal bureau to hide themselves like whipped curs to gnaw their small bones in obscure corners? For if an investigator does not keep quiet about his work he knows perfectly well that, upon one pretext or another, he is likely to be pounced down upon and his work taken out of his hands—and 'due credit given,' of course! It is all very well for the director of the survey to say that he had no intention of doing such things. He has the power to do them and he does them.

The second proposition is that the national survey has discredited and enfeebled the state surveys, and that it prevents their normal growth even when it does not entirely drive them out of existence.

The truth of this statement is so self-evident that it hardly admits of discussion. The cases quoted above are proof enough, and instances more or less similar can be found in almost every state where state surveys still exist, and in other states where the surveys have been killed off through the influence, direct or indirect, of the national survey. This is the more important because the state surveys are vastly more useful to the states and to state industries than is the national survey. The state surveys, however small they may be, are in touch with the people, keep alive an active local interest in geology, and serve as a valuable training school for young geologists. And this widespread interest in science is not only important, but above all is it important that the people of this country be left to manage their own home affairs even though they may not manage them so well, rather than to have them directed by a bureau at Washington, run as a great scientific trust and paid for at the rate of millions of dollars a year out of the public funds.

It is no part of the functions of a national government to interfere with and to discredit state and other local governments, and just as little should it be a function of any national scientific bureau to weaken, patronize, or in any way discredit state and other local scientific work.

The third proposition is that a systematic effort is being made by the present director to deprive university professors of the support of the national survey to carry on work that falls or should fall naturally to them.

It is a matter of common knowledge that many of the professors of geology over the

country have received from the U. S. Geological Survey small allotments of money that enabled them to spend their holidays and odd hours in doing geologic work in which they were especially interested. This work has yielded excellent and far-reaching results both for the national survey and locally. It has greatly encouraged the younger geologists, for it has generally been regarded as a sort of official recognition of their professional ability and standing, it has enabled them to widen their knowledge and experience, and not infrequently it has enabled the poorly-paid teachers to keep their heads above water financially. This policy has justly strengthened the survey throughout the country. The survey seems to feel, however, that it has now outgrown the necessity of this kind of support, and the time has come when these professors are to be dropped as rapidly as it can be done without precipitating matters. The director probably realizes at the same time that, as long as the names of these professors are on the payroll of the survey, they are not going to quarrel with their bread and butter. The professors must face the situation whether they wish to do so or not, for here is the policy set down in black and white:

Mr. Walcott says in his letter given above that the professors "can not work as efficiently for the national survey as can the geologists constantly in its employ, and recognition of this fact has led in recent years to a reduction of the proportional amount of work allotted to teachers of geology, who can give but a share of their time to it." This statement of the case is straightforward and the question is well defined. Even if it were not so clearly put, the course of the survey during several years past made this plan apparent. Mr. Walcott's policy has lately made itself quite apparent also in the conduct of the Carnegie Institution of which he was for several years the secretary, and of whose executive committee he is still a member.

This plan on the face of it seems reasonable. It is to be noted that there is no complaint of the grade or character of the work done by the professors, it is simply that they can not give their entire time to it, and that they are therefore and necessarily slow in handing in results.

The fourth proposition is that such a system of discrimination by a national bureau against the scientific work of university professors discredits scientific instruction in the universities, and must inevitably react against the men who devote themselves to scientific work and study, against the dignity and usefulness of the teacher's vocation, against the high character and efficiency of scientific instruction in our institutions of learning, and eventually against science itself.

Science in this country has come chiefly from the educational institutions. It is in them that standards are set and maintained, and it is from them that the most incisive scientific thought has come. If the professors have been slow, they have also been painstaking and trustworthy. They have worked at science because they loved it, and their deep interest in their work and their unselfish and often fatal devotion to it has been a constant inspiration to their students, and a source of strength to the institutions with which they have been connected. Unfortunately, these professors have small salaries and they have little or no money with which to carry on their researches or original work, and even the little they have often comes out of their own slender private funds. There is another reason for this slowness of the professor that is not likely to appeal to the director of the survey: I refer to the fact that the amount of money allotted to the work to be done by a professor in the survey's employ is sometimes so small that he is unable to finish a given piece of work within a specified time and to do it as he thinks it should be done. In his letter of November 9 my own case is cited in evidence of the delay of the professors in handing in their results. The allotments made for the work mentioned (the Santa Cruz quadrangle) were so small that in order to do the work properly I was obliged to spend about a thousand dollars of my own money. Dr. Newsom, who joined me in this work, likewise paid out about seven hundred dollars to help put the work in better shape. Dr. Newsom's bill was finally presented to the survey and

was paid; I have never asked for reimbursement. This case is not mentioned for the purpose of excusing my own delay, but as affording an explanation of why university professors are sometimes slow, and to suggest at the same time that slowness may not be quite as bad as haste when that haste brings forth slip-shod results.

Here again the slowness of the professors is liable at any moment to be made an excuse for invading our fields of operations. Thus the whole tendency of the survey's policy of haste is towards more haste and poorer work.

I acquit Mr. Walcott of any intention to discredit professors by his policy. With his intentions, however, we have nothing to do; it is with his methods and results that we are concerned. We can not discredit the source of instruction and keep the instruction efficient. This wholesale discrimination against the universities can have no other results than those mentioned: discredit to the professors, eventual loss of efficiency and a corresponding reaction upon the universities and upon science.

Finally, if this policy were confined to the geological survey proper there would be less to fear from it. But unfortunately the geological survey has expanded far beyond the legitimate fields of geologic work. Forestry, irrigation, water-supply, reclamation and engineering have been added to its functions, and it has occasionally looked longingly toward the Coast and Geodetic Survey, and I know not what more besides. This expansion, under Mr. Walcott's policy, simply increases the field of its possible powers of demoralization for education and science.

Furthermore, this same policy is already being put into active operation in the Carnegie Institution, and Mr. Walcott is now a candidate for the position of secretary of the Smithsonian Institution, where he could be counted upon to put it in still further practise. With a great overgrown national bureau already committed to this policy and with these two endowed institutions of research under similar control, the university professors of the sciences in this country and the universities themselves are face to face with a serious problem.

In connection with this question I have frequently been reminded that the geological survey has come to be a great scientific trust; that trusts and trust methods are in the air, and that there is little hope of success in fighting them, especially in view of the support commanded by the millions of dollars they receive every year. Very true; but there is also in this same air protest, rebellion and resentment against these high-handed methods, and especially so when they are paid for out of the national treasury.

J. C. Branner.

Stanford University, California,
November 22, 1906.

Evolution (Cook) and Mutation (Waagen).

Dr. O. F. Cook recently has published[1] a reply to my criticism of his views published some time ago,[2] but it only evades the main point at issue, and introduces, in its stead, a new topic, which had not entered the discussion before.

While I practically said, with reference to a previous article of Dr. Cook's,[3] that his distinction between 'evolution' and 'speciation,' although correct, is not new, and objected to the term 'evolution,' he meets this with the rejoinder, that there is a distinction between 'heterism' and 'evolution'; and since he regards this distinction as new, as a progress in science, he claims the right to use the old term evolution in a new, restricted sense.

However, also this new point in the discussion does not justify Dr. Cook, for it is *not new to science*. 'Evolution,' as he understands it, has been often classed with 'variation,' as I have also done in my previous article. Nevertheless, as Dr. Cook maintains, there *is* a distinction between 'evolution,' the 'progressive transformation of species' in time, and 'heterism' (or variation proper) of coexisting individuals. But in this sense 'evolution' is absolutely identical with

[1] Science, September 7, 1906, p. 303.
[2] Science, April 27, 1906, p. 667.
[3] Science, March 30, 1906, p. 506.

what Waagen[4] called 'mutation,' a term that has been accepted and frequently used by paleontologists (for instance Neumayr,[5] W. B. Scott[6] and also the present writer[7]). The same idea is implied in Eimer's term 'orthogenesis,'[8] which has also been used by subsequent writers.[9] Thus, 'other terms being available,'[10] there is absolutely no need to accept the confusing change of the meaning of the word 'evolution.'

Dr. Cook holds, that 'evolution' (correctly, according to the rule of priority, 'mutation,' Waagen) is made possible by two factors, 'heterism' (the normal diversity of individuals) and 'symbasis' (interbreeding = amphimixis, Weismann). This is by no means correct, for it is unintelligible how interbreeding of different individuals should be able to result in a 'progressive change' of the species. Amphimixis only serves to maintain the average of a number of individuals, which vary around this average,[11] and, moreover, it is not an absolutely necessary factor in evolution (old sense), which is evident at once, when we consider that there are organic forms, which lack sexuality.

As to the real causes of mutation (Waagen) I refer to my discussion of this subject in a previous paper,[12] which in the main accepts the views set forth by Pfeffer in a special treatise on this question.[13] According to this, mutation of a species, its transformation in time, is the evolutionary process restricted to a single species; it includes all factors of evolution (old sense) except one, segregation, which, when added, causes the splitting up of one species into two or more.

With reference to my belief that acquired characters are transmitted, and that all variation is due to environment, Dr. Cook maintains that 'heterism,' the diversity of coexisting individuals, is 'normal,' that is to say, an innate quality of organisms, and he asserts that there are no facts which support the doctrine that conditions of environment cause this diversity. I recommend to him to read again the last two paragraphs of my article,[14] and further, what I have said on these topics elsewhere,[15] for he has not paid attention to these arguments. The thesis propounded by Dr. Cook, that 'individual diversity persists in spite of uniformity of conditions,'[16] may be met by the antithesis: *if the environment remains uniform, perfect uniformity of individuals will result.*[17] But since it is practically impossible that any two individuals grow up under precisely the same conditions, a diversity of individuals results. This is a fundamental law. It is, however, not an innate, inexplicable quality of organisms, but is due to the external conditions, which continuously are changing and varying,

[4] 'Die Formenreihe des Ammonites subradiatus,' in Benecke's 'Geogn.-Palæontol. Beitr.,' 2, pp. 179–256.

[5] 'Die Staemme des Thierreichs.' 1, 1889, pp. 60, 61.

[6] 'On the Osteology of Mesohippus and Leptomeryx, with Observations on the Modes and Factors of Evolution in the Mammals,' in *Journ. Morphol.*, 5, 1891, p. 387, 388. 'On Variations and Mutations,' in *Amer. Journ. Sci.*, 48, 1894, p. 355.

[7] 'Grundzüge der marinen Tiergeographie,' 1896, pp. 30, 31. 'On Natural Selection and Separation,' in *Pr. Amer. Phil. Soc.*, 35, 1896, p. 176.

[8] 'Die Artbildung und Verwandtschaft bei den Schmetterlingen,' 2, 1895, p. 3. 'Orthogenesis der Schmetterlinge,' 1897, pp. i–xii.

[9] For instance, quite recently by Paul Sarasin, in *Verh. deutsch. zool. Ges.*, 1906, p. 137.

[10] Ortmann, in SCIENCE, *l. c.*, p. 668. 'Transformation' might also answer; it corresponds to the German 'Umwandlung,' as used by Pfeffer.

[11] See Ortmann, in *Biolog. Centralblatt*, 18, 1898, pp. 146–149. (In opposition to Weismann's view of the action of amphimixis; see Weismann, 'Amphimixis,' 1891.)

[12] *Pr. Amer. Phil. Soc.*, *l. c.*

[13] Pfeffer, 'Die Umwandlung der Arten, etc.,' in *Verh. Naturw. Ver. Hamburg* (3), 1, 1894.

[14] SCIENCE, *l. c.*, p. 669.

[15] *Biol. Centralbl.*, *l. c.*, p. 153. SCIENCE, June 22, 1906, p. 951.

[16] SCIENCE, *l. c.*, p. 306.

[17] See Davenport, in SCIENCE, November 25, 1904, p. 704: 'Two individuals of the same family develop alike only under the same conditions of environment.' See also Copeland, in *Bot. Gaz.*, 38, 1904, p. 426.

and thus a uniform response of individuals to environment is rendered impossible.[10]

A. E. Ortmann.

Carnegie Museum, Pittsburg, Pa.,
September 22, 1906.

DISCONTINUOUS VARIATION.

Dr. Jordan's kindly comment upon my Wood's Hole lecture would place me at a great disadvantage if I were inclined to be controversial (Science, 24: 399, 1906). This, however, is farthest from my purpose, and in fact is unnecessary since I find myself in agreement with him on most of the points brought up.

Too much emphasis can not be put upon some of the statements reiterated or advanced by Dr. Jordan, and he has certainly performed a very useful service by approving the principle that the students of a group, or of any phase of life are more likely to acquire better first-hand knowledge of it, and to render truer interpretations of the facts obtained than other writers. As vividly obvious as this may be, it has been necessary to be unpleasantly insistent upon it upon various occasions during the last few years, and to reassert that botanists are better fitted by opportunities and training for the comprehension of the nature and behavior of plants than any other class of naturalists. The dictum of Darwin so aptly quoted has never been more strictly applicable than at the present time, and an intimate and accurate acquaintance with a large number of species constitutes a very important share of the competency for profitable study of evolutionary problems. Whether or not the investigator publishes his descriptions is purely incidental.

On the other hand, it is not to be granted (and happily it is not) that a keen critical sense in nomenclature, or a zeal for the acquisition, making or conservation of type specimens forms a suitable equipment for the intelligent consideration of genetics, although when coupled with detailed studies in life-histories, cultures and field observations, the activities in question become of very great value in this connection.

During the last few years I have had occasion to discuss the species-idea with several of the more active systematic botanists, and find that the theoretical conceptions of species formulated by them vary widely, although overlapping in many essential points in all instances. Now these differences of opinion by no means lead me to deprecate species-making, or to distrust the value of the species erected by these workers, although known to apply differing standards. This knowledge and this confidence are shared by the general botanical public. The difficulty in delimiting in so many words the difference between continuous and discontinuous variation is of a similar character, and was recognized by myself in the earliest review of the work of de Vries on the subject published in an American journal in the following words: "From the reviews and discussions which have already been made of de Vries' papers it is to be seen that the greatest misunderstanding which may likely arise in the consideration of his results will be that founded on the error of confusing fluctuating variability and mutability." In this as well as in the consideration of species it is found that our difficulties disappear when we deal with concrete examples, especially if embraced in a pedigreed culture. To be able to examine a number of organisms in the field and determine which are continuous and which are discontinuous variants is not possible, for numerous reasons, although many botanists have assumed to do so.

What the actual origin of *Œnothera Lamarckiana* may have been can not be said. we can vouch for the actual origin of but few species. If records are to be trusted, however, it was in cultivation in the Paris Garden a century ago. My own breeding experiments have included a number of crosses involving various combinations of species from eastern

[10] See Brooks, 'Heredity and Variation: Logical and Biological,' in *Pr. Amer. Philos. Soc.*, 45, 1906, p. 75. 'The species is * * * in that reciprocal interaction between the living being and the natural world, of which it is a part.' This paper of Brooks is quite interesting and important. Although largely written in terms rather unusual in the discussion of evolutionary matters, it brings out ideas, which, if I correctly understand them, are essentially in agreement with my own views.

North America as indicated, have been under way for several years, have been visited by perhaps a dozen zoologists interested in problems of heredity as well as by a large number of botanists. When the major purpose of the cultures shall have been accomplished it will be possible to publish the account of the whole to some advantage.

In re hybrids I venture to suggest that if I were a 'Mendelist' of the strictest sect I would welcome a challenge to bring the oak and walnut hybrids under the chess-board diagrams for the exposition of the possible combinations. The unflinching advocates of the Mendelian formulæ are confronted with much more serious difficulties than the examples in question. The enormous accretions being made in the range of authenticated facts of inheritance in hybridization have thrown the whole subject into a state of flux and not for a long time may we hope to work under such simple generalizations as those which contented us a decade since.

It is not intended to maintain that the horse has climbed up on his tiptoes, the bacterium settled into its highly specialized medium and that the orchids have come by their intricate flower-mechanism by the same process. Selection undoubtedly plays an important part, although we seem unable to agree upon the manner in which it operates. One can not be a field student of plants to any great extent without coming upon striking facts in segregation and isolation. This is found especially in the studies now being made of the distribution of the components of the flora of the Bahamas and West Indies. Until we see further around the bend of the road, however, we may make but futile guesses as to the direction of the straight-away beyond. The great amount of energy now being put on detailed studies in this subject at the Desert Laboratory and elsewhere is yielding a great range of diverse data, and affords the hope that some definite conclusions may be expected, within a time comparatively brief, when contrasted with the long barren period in which nothing of definite value as evidence in evolutionary problems has been produced.

In this and other phases of the subject we are confronted with the necessity of placing ourselves alongside some of the organisms which share the earth with us, in order to follow with them along their devious trails for what distance we may, and thus gain some clue as to the rate, direction and character of their movements.

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October 8, 1906.

THE PUBLIC HEALTH DEFENCE LEAGUE.

TO THE EDITOR OF SCIENCE: With the object of devising ways and means for the preservation of the public health and morals there was held in New York City on November 15, an important conference, which should be of interest to readers of SCIENCE. Several hundred delegates from over a hundred well-known organizations then gathered in the Hudson Theater and launched the Public Health Defence League. The inclement weather without did not in any way dampen the enthusiasm of those who were enlisting themselves in a fight to down quackery in any of its various forms and to enforce existing laws for the securing of pure food and drugs, for the suppression of the criminal abortionist, and for other lines of work of a similar nature.

The conference committee consisted of: Dr. Wendell C. Philips, Silas F. Hallock, Dr. Floyd M. Crandall, Dr. Henry W. Cattell, Walter F. C. Tichborne, Albert M. Austin, Dr. Walter Lester Carr, Mr. Howard J. Rogers, Dr. Ernest J. Lederle, Mr. J. M. Rice, Harold P. Brown, Dr. Henry S. Stearns, Livingston Farrand, Rev. J. J. Wynne, Dr. William M. Polk, O. E. Edwards, Gaylor S. White, Dr. Frank Van Fleet, Eugene O'Dunne, Rev. Thomas R. Slicer, Dr. Thomas Darlington, Austen G. Fox, Dr. William L. Browning, Robert E. Belcher, John S. Cooper and Champe S. Andrews, much credit being due to the latter gentleman for his work in organizing the meeting.

Mr. Austen G. Fox, who did such good work as attorney for the committee of fifteen some years ago in regard to the social evil, presided at the meeting. The delegates were welcomed by President McGowan, of the Board of Alder-

men, the first speaker being Mr. Charles F. Stewart, a reporter on the *Cleveland News*. He most entertainingly described how, after a thorough physical examination had shown him to be in good health, the various quacks and charlatans in Cleveland, one of whom was able to expend $80,000 a year for postage stamps alone, pronounced him suffering from various diseases of an unmentionable nature. Among the other speakers were Mr. Eugene O'Dunne, of Baltimore; Mr. Thomas W. Barlow, of Philadelphia, and Mr. Anthony Comstock, of New York.

It seems as if politics can not be run without a boss or the laws upon our statute books be properly enforced without special societies for this purpose. The success of such a movement started from without the medical profession, but with every aid extended to it by physicians, will be even more marked than if it had been undertaken under the auspices of such an organization as the American Medical Association. The chief difficulty to cope with will be to formulate a working plan so that the various branches will be able to cooperate most efficiently with the parent chapter. As was pointed out in the remarks of Dr. Charles A. L. Reed, of Cincinnati, one of the first things to do is to make the laws of our different states bearing upon public health and morals uniform. Thus it would be advisable to have the present United States pure food and drug law passed by the legislature of each state, and to frame a law making it a penal offence to offer to perform a criminal operation and to revoke the license of any physician who upon due process of law has been convicted and sentenced for the performance of such illegal act. To prosecute work of this character and the sanitation of to-day there should be created a national department of health with its head a member of the Cabinet, as so ably advocated by Professor Norton, of Yale. H. W.

SPECIAL ARTICLES.

A STATISTICAL STUDY OF AMERICAN MEN OF SCIENCE. III.

THE DISTRIBUTION OF AMERICAN MEN OF SCIENCE.

From a conventional point of view the distribution of men of science would not be regarded as a psychological problem, perhaps not even as a scientific problem. But in recent years the distribution of plants and animals has received increasing attention in botany and zoology, and apart from its pertinence as a correct description of the world in which we live, it has proved, on the one hand, to have certain practical applications, and, on the other hand, to throw light on certain general problems of heredity and evolution. Similar results may accrue from a scientific study of the distribution of human ability and performance.

The birthplace and the present residence of the thousand leading men of science of the United States are shown on the accompanying table, the divisions used being those of the census. Figures are given separately for the five hundred (I.–V.) who are more distinguished and for the five hundred (VI.–X.) whose reputations are less, followed by the totals and their number per million of the population. As the average age of the scientific men is about 45 years, their birth rate is referred to the census of 1860.[1] Thus the first line of the table shows that 29 of the 1,000 scientific men were born in Maine, and four now reside there. Of the 29 scientific men born in the state, 19 are among the 500 who are more eminent and 10 among the 500 who are less eminent. The number born was at the rate of 46.1 per million of the population at the approximate time of their birth, or one for each 22,000. The scientific population of the state is now only at the rate of 5.7 per million of the population, or scarcely more than one for each 200,000.

There are striking variations in the origin and in the present residence of scientific men throughout the United States. Massachusetts and Boston have been the intellectual center of the country. The birth rate of these leading men of science is in Massachusetts 108.8 per million population; it is 86.9 in Connecticut,

[1] This is not exact, as the age distribution is not symmetrical, and the rate of increase of the population in the different states is not uniform, but the results are as nearly correct as is necessary.

and decreases continually at greater distances from this center. It is reduced to about one half in the surrounding states—46.1 in Maine, 46 in New Hampshire, 57.1 in Vermont and 47.2 in New York. There is a further reduction to one half in Pennsylvania—to 22.7—and this proceeds as we go southwards, the rate being 8.8 in Virginia, 5 in North Carolina, 2.8 in Georgia, 2.1 in Alabama, 1.3 in Mississippi and 1.4 in Louisiana. In the north central states the conditions are intermediate between New York and Pennsylvania. Thus the birth rate per million is 32.1 in Ohio and 36 in Michigan. Here again it decreases as

TABLE I. DISTRIBUTION OF THE THOUSAND MEN OF SCIENCE.

	Birthplace.			Per Million 1860.	Residence.			Per Million 1900.
	I.-V.	VI.-X.	Total.		I.-V.	VI.-X.	Total.	
North Atlantic Division.								
Maine	19	10	29	46.1	0	4	4	5.7
New Hampshire	7	8	15	46.0	2	6	8	19.4
Vermont	9	9	18	57.1	0	2	2	5.8
Massachusetts	60	74	134	108.8	74	70	144	51.3
Rhode Island	4	1	5	28.6	7	1	8	18.7
Connecticut	26	14	40	86.9	27	16	43	47.3
New York	99	84	183	47.2	93	99	192	26.4
New Jersey	9	19	28	41.6	17	18	35	18.5
Pennsylvania	32	34	66	22.7	28	37	65	10.3
South Atlantic Division.								
Delaware	0	2	2	17.8	0	1	1	5.4
Maryland	12	14	26	37.8	24	23	47	39.5
District of Columbia	1	2	3	39.9	69	50	119	426.9
Virginia	5	8	13	8.8	8	2	10	5.4
West Virginia	1	0	1		2	1	3	3.1
North Carolina	1	4	5	5.0	3	3	6	3.2
South Carolina	2	3	5	7.1				
Georgia	1	2	3	2.8	0	1	1	1.4
South Central Division.								
Kentucky	6	2	8	6.9	1	2	3	1.4
Tennessee	5	1	6	5.4	2	1	3	1.5
Alabama	1	1	2	2.1	1	1	2	1.1
Mississippi	1	0	1	1.3				
Louisiana	1	0	1	1.4	0	1	1	.7
Texas	0	3	3	4.9	2	5	7	2.3
North Central Division.								
Ohio	42	33	75	32.1	13	21	34	8.2
Indiana	17	11	28	20.7	4	8	12	4.7
Illinois	24	18	42	24.5	36	27	63	13.1
Michigan	12	15	27	36.0	22	5	27	11.1
Wisconsin	11	24	35	45.1	11	12	23	11.1
Minnesota	1	3	4	23.2	3	10	13	7.4
Iowa	6	14	20	29.6	5	2	7	3.1
Missouri	4	10	14	11.8	7	14	21	6.7
North Dakata					0	2	2	6.2
South Dakota					0	2	2	3.9
Nebraska	1	1	2	69.3	4	5	9	8.4
Kansas	5	2	7	65.3	2	3	5	3.4
Western Division.								
Montana					0	2	2	8.2
Wyoming					0	1	1	10.8
Colorado	0	3	3	87.2	3	5	8	14.8
New Mexico					0	2	2	10.2
Arizona					1	1	2	16.3
Washington	1	0	1	86.2				
California	5	6	11	23.9	23	30	53	35.7
Alaska					0	1	1	15.7
Hawaii	1	0	1					
Philippine Islands					2	1	3	
Total	432	435	867	27.6	496	498	994	13.3

	Birthplace.			Per Million 1860.	Residence.			Per Million 1900.
	I.–V.	VI.–X.	Total.		I.–V.	V.–IX.	Total.	
Canada	11	23	34	*28.7*	1	1	2	
Brazil					1	0	1	
Cuba					0	1	1	
England	10	15	25	*29.6*	1	0	1	
Ireland	2	1	3	*1.8*				
Scotland	6	3	9	*37.9*				
Wales	0	1	1	*10.7*				
West Indies	0	1	1	*69.1*				
Germany	15	4	19	*7.1*				
Austria-Hungary	4	2	6	*10.4*				
Norway	1	0	1	*2.9*				
Sweden	2	1	3	*5.2*				
Denmark	0	2	2	*12.9*				
Switzerland	4	4	8	*68.9*				
Russia	4	2	6	*7.4*				
Italy		1	1	*2.1*				
Spain	0	1		*137.3*				
Turkey					1	0	1	
India	4	0	4	*193.3*				
China	1	1	2	*18.7*				
Total	64	62	126		4	2	6	
Grand Total	496	497	993		500	500	1000	

we go southward. The rate is 45.1 in Wisconsin, 24.5 in Illinois, 11.8 in Missouri and 6.9 in Kentucky. Westward the total number of scientific men is too small and the population has been too rapidly increasing for the figures to be reliable. Each individual should be considered in connection with the population at the time of his birth, but even in this case the validity of the results would be small.

Of the 1,000 scientific men, 126 were born in foreign countries—34 in Canada, 38 in Great Britain and 19 in Germany. The birthplace of seven is not known. The number per million is for the native population 13.2, and for the foreign-born population 12. These figures have, however, no significance, as the foreign-born population contains a much larger proportion of adult males. The percentage of the white native population in the United States over 40 years of age is 18.4, and of white foreign-born is 44.4. The native population consequently produces more than twice as many scientific men as the foreign-born, even without regard to the excess of males among the foreign-born, the inclusion of the colored races among the native-born and the fact that many of the foreign-born have been called to this country on account of their scientific standing. The different nations contribute scientific men in very unequal measure, the numbers per million foreign-born being as follows: Switzerland, 68.9; Scotland, 37.9; England, 29.6; Canada, 28.7; Austria-Hungary, 10.4; Russia, 7.4; Germany, 7.1; Sweden, 5.2; Italy, 2.1; Ireland, 1.8; France, 0. These differences can not be attributed to race, as they do not represent the scientific productivity of these nations, but only of the classes that have emigrated to this country. While it is not possible to deny that the variations are dependent on the kinds of family stocks, it is probable that they are due in much larger measure to social and economic conditions. The native-born sons of Irish-born parents may not be inferior in scientific productivity to other classes of the community.

The inequality in the production of scientific men in different parts of the country seems to be a forcible argument against the view of Dr. Galton and Professor Pearson that scientific performance is almost exclusively due to heredity. It is unlikely that there are such differences in family stocks as would lead one part of the country to produce a hundred times as many scientific men as other parts. The negroes may have a racial

disqualification, but even this is not proved. The main factors in producing scientific and other forms of intellectual performance seem to be density of population, wealth, opportunity, institutions and social traditions and ideals. All these may be ultimately due to race, but, given the existing race, the scientific productivity of the nation can be increased in quantity, though not in quality, almost to the extent that we wish to increase it.

There may be no significant difference in the distributions of the first and second groups of 500. Some states have produced men of higher average standing than others, but the differences are within the range of possible chance variations. Thus Maine has produced 19 men of the first rank and 10 of the second. But if 29 pennies are tossed up, there is one chance in 14 or 15 ($P = .068$) that there will be 19 or more heads. It is, however, true, as a matter of fact, that Maine, Connecticut, Ohio, Indiana and Illinois have produced men of decidedly higher average standing than New Jersey, Wisconsin, Iowa and Missouri. Those born in Germany are considerably above and those born in Canada are below the average, and the figures may here represent a real difference in the classes drawn to this country.

The fact that there is not a significant difference in the average standing of scientific men born in different regions of the country tends to support the conclusion that scientific performance is mainly due to environment rather than to innate aptitude. If the fact that Massachusetts has produced relatively to its population four times as many scientific men as Pennsylvania and fifty times as many as the southern states were due to a superior stock, then we should expect that the average standing of its scientific men would be higher than elsewhere; but this is not the case. Like most arguments intended to disentangle the complex factors of 'nature and nurture,' this, however, is not conclusive. If scientific ability were innate, each tending to reach his level in spite of environment, then a potentially great man of science would become such wherever born, and we might expect a favorable environment to produce mediocre men, but not great men. But this argument is answered by the small number of scientific men from certain regions of the country. Differences in stock can scarcely be great enough to account for this; it seems to be due to circumstance. A further analysis of the curves of distribution might throw light on the problem. Thus it might be that the men of greatest genius were independent of the environment, while men of fair average performance were produced by it. Examples might be given in favor of this view, but I can not see that it is supported by the forms of the curves of distribution. I hope at some time to take up the question from a study of individual cases, but I have not as yet the data at hand. My general impression is that certain aptitudes, as for mathematics and music, are mainly innate, and that kinds of character and degrees of ability are mainly innate, but that the direction of performance is mainly due to circumstances, and that the environment imposes a veto on any performance not congenial to it.

The present distribution of the 1,000 men of science is somewhat the same as their origin. The population of the country has more than doubled since 1860, and the number of these scientific men per million population is consequently less than half the number per million at the period of their birth. There are in Massachusetts 144 of the 1,000, which is 51.3 per million of the population, according to the census of 1900. The numbers then decrease to 26.4 per million in New York, 10.3 in Pennsylvania, 13.1 in Illinois, 8.2 in Ohio, 3.1 in Iowa, 1.1 in Alabama, 0.7 in Louisiana and 0 in Mississippi. The most striking development has been the attraction to Washington of a large group of scientific men, 119 of the thousand, nearly all in the service of the government. This number has been almost exactly supplied to the country by the excess of scientific men born abroad—120. This leaves an equal balance between the gains and losses of other parts of the country. The greatest gain has been made by California, which has drawn 42 of the scientific men from other states; Illinois and Maryland have each gained 21. Other states have gained consider-

ably in proportion to their total scientific population—New Jersey, 7, Minnesota 9, Missouri 7, Nebraska 7 and Colorado 5. These gains appear to be significant, attributable to the establishment and growth of universities.

Massachusetts, New York and Pennsylvania have remained nearly stationary. Massachusetts has gained ten of the scientific men and New York nine, while Pennsylvania has lost one. The conditions in New York are by no means creditable to that state, in view of its great increase in wealth. Outside New York City, the state has lost 31 men of science, nearly one third of those it has produced, and half the others are concentrated at Ithaca. The conditions are somewhat similar in Massachusetts and Pennsylvania, outside Boston, Cambridge and Philadelphia.

The rural New England states, Maine, New Hampshire and Vermont, have lost 48 of the 62 scientific men whom they have produced. This is a loss that they can ill afford; it signifies a distinct decadence. Had each of these states provided an income of $50,000 to retain these men in their service, they would have been repaid manyfold, commercially as well as intellectually. The conditions in some of the north central states are also ominous, though more likely to improve. Thus Ohio has lost forty-one of its scientific men, more than half of those whom it has produced; Indiana has also lost more than half and Iowa just half. The south remains in its lamentable condition of scientific stagnation, but we may hope that material progress will be followed by an intellectual awakening. All these figures become more impressive when we remember that they indicate performance in scholarship, in literature and in art, as well as in science. It would be well if they were widely known, as they would tend to awaken civic pride and to improve the conditions of intellectual activity.

The average standing of the scientific men residing in different parts of the country varies a little more than the standing of those produced in different regions and is perhaps less likely to be due to chance variations. This appears to be somewhat paradoxical from the point of view of the theory of probabilities. The fact that of the 75 scientific men born in Ohio, 42 belong to the first group and 33 to the second is a natural result of chance distribution, and the fact that of the 34 scientific men remaining in the state, 13 belong to the first group and 21 to the second might equally well be the result of chance distribution. But apparently it is not. Ohio has lost more than half the scientific men it has produced; it has lost two thirds of its better men and one third of its more mediocre men. The state has not provided for its scientific men, and has provided less adequately for the better men than for those who are not so good. Indiana has lost three fourths of its men of the first class and one fourth of those of the second class. The three rural New England states have lost seventeen eighteenths of their men of the first class and one half of those of the second class. These conditions are significant and serious.

Other states have improved their positions. Thus, thanks to its great university, Michigan has 22 men in the first group as compared with five in the second. Thanks again to its universities, Illinois has increased its number of scientific men from 42 to 63, of whom 36 are in the first class. California, Missouri and Minnesota have, on the other hand, called men who are below the average.

The large centers of scientific population in Massachusetts and New York have about maintained their positions, having produced men of about average standing and their resident men of science being of about average standing. Massachusetts has, however, gained a little and New York has lost a little. Of the 119 scientific men in Washington, 69 are in the first group and 50 in the second. This appears to me to be a fact of very great importance. It is commonly said that less able scientific men are attracted to the government service, that those who are able leave it for university positions and that those who stay are not encouraged to do their best work. Such statements are refuted by these statistics. The average performance of the scientific men at Washington is higher than in Massachusetts or in New York. This conclusion is most gratifying to those of us who believe that the future of scientific research depends large-

ly on its support by the nation, the states and the municipalities.

The writer has on various occasions called attention to the economic conditions which limit scientific research. As one of the objects of the present work is to improve these conditions, it may be well to repeat here the argument. Our economic system rests on the free exchange of services. A state of society may some day be reached in which each will aim to give as much as he can and to take as little, but at present it appeals to our sense of fairness that each should ask for his services what someone else is willing to pay. In the increasing complexity of our society this method is working two serious injustices. One of these is the formation of monopolies. Thanks chiefly to the applications of science, many services can now be supplied at a cost less than people would be willing to pay. When free competition is excluded, either by the conditions of the case or by ingenious combination, people may be made to pay more than a fair return for certain services. The problems of monopoly are being discussed on all sides, and remedies are being sought in all directions; but the injustice which in a way is the converse of monopoly has scarcely been noticed. This is the case in which an individual gives services without an adequate return, owing to the fact that they are not rendered to a single individual or group who will pay for them, but to society as a whole. A surgeon may ask for an operation for appendicitis as large a fee as his patient is willing to pay, but should he after years of research discover a method of preventing appendicitis altogether, he would receive no payment at all, but would, on the contrary, give up all future fees for the operation. The surgeons who by risking and sacrificing their lives discovered how to suppress yellow fever have received no return for their great work.

The two most important services for society —the bearing and rearing of children and creation in science and art—are exactly those for which society gives no economic returns, leaving them dependent on instincts which are in danger of atrophy. This state of affairs not only does injustice to the unrewarded individual, but works immeasurable harm to society—a greater injury probably than all existing monopolies. There are more than a hundred thousand physicians in the United States who are practising on their patients for fees, while there are scarcely two hundred who are studying seriously the causes of disease and the methods of preventing it. The conditions are similar in law and in all professions and trades. The scientific investigator is usually an amateur. He has wealth or earns his living by some profession, and incidentally does what he can to advance science for love of the work. This has its good side in producing a small group of men who are not subject to purely commercial standards. But this is after all a minor factor, and the scientific man is likely to look for fame, which is scarcely more ideal than money and can be supplied to but few. Satisfaction in the work itself is the best reward for work; but no one can know that his work is of value except by the reflected appreciation of others, and in the existing social order the simplest and probably the most adequate expression of this appreciation is direct payment for the service rendered.

The methods that society has devised to meet this situation, apart from the conferring of honors and fame, are recent and inadequate. Copyrights and patents are the most direct acknowledgment of property in ideas. They have accomplished a good deal, and their scope should be extended. At present only a small part of discovery is covered by the patent office, and this perhaps not the part requiring the greatest genius. It is, however, leading, especially in Germany, to the development of discovery on a sound commercial basis. It is said that one chemical firm employs three hundred doctors of philosophy to carry on scientific investigations. Research has hitherto been forwarded mainly by the universities, where again Germany has led the way. The professorship is given as a reward for successful investigations, and the holder of a chair is expected to devote himself to investigation as well as to teaching. There is a tendency to permit certain professors to engage almost exclusively in research. Thus the astronom-

ical observatories of Harvard, Chicago and California universities are purely research institutions. A further step has been taken in the endowment of institutions, such as the Carnegie Institution and the Rockefeller Institute, explicitly for research. The most logical and important advance, however, consists in the direct conduct of research by the government. As the government should control monopolies, so it should conduct the work which is not for the benefit of a single individual, but for the people as a whole. There are, of course, no end of difficulties in the control of monopolies or the conduct of research by a municipality, state or nation; but it is exactly these difficulties that it is our business to overcome. We may congratulate ourselves that our national government is at present accomplishing more for research and the applications of science than the government of any other nation, and that the men of science working under the government are doing their full share for the advancement of science.

Table II. gives the cities in which five or more of the thousand scientific men were born, and the cities in which five or more of them now reside. The tendency towards concentration which we know to exist is here measured. Two hundred and twenty-seven of the scientific men were born in places producing five or more, and 782 of them live in places where there are five or more. This is, of course, natural, and probably desirable; scientific work is accomplished where men gather together. Still the fact that three fourths of our scientific men live in 39 places—with a good many more in the suburbs—leaves rather a scanty number for the rest of the country. We have, however, more separate scientific centers than foreign countries, and by this circumstance we both gain and lose. The lack of men of distinction in whole regions and large cities is a serious indictment of our civilization. The existence of cities such as Brooklyn and Buffalo is an intellectual scandal.

Of the 866 men native to the United States, 224 were born in the cities which in 1900 had a population of more than 25,000. These

Table II. Distribution in Different Places.

	According to Birthplace.			Per Million 1860.
	I.-V.	VI.-X.	Total.	
New York, N. Y.	33	25	58	*71.2*
Boston, Mass.	24	19	43	*241.8*
Philadelphia, Pa.	12	16	28	*49.5*
Baltimore, Md.	9	11	20	*94.1*
Cincinnati, O.	6	6	12	*74.5*
Brooklyn, N. Y.	3	8	11	*39.4*
Chicago, Ills.	5	3	8	*73.2*
Buffalo, N. Y.	3	4	7	*86.2*
St. Louis, Mo.	2	5	7	*43.5*
Cambridge, Mass.	4	2	6	*230.2*
Cleveland, O.	4	2	6	*140.5*
Salem, Mass.	1	5	6	*269.6*
Milwaukee, Wis.	1	4	5	*110.5*
Newark, N. J.	3	2	5	*69.5*
San Francisco, Cal.	2	3	5	*88.0*
Total.	112	115	227	

	According to Residence.			Per Million 1900.
	I.-V.	VI.-X.	Total.	
Washington, D. C.	69	50	119	*426.9*
New York, N. Y.	61	54	115	*56.1*
Brooklyn, N. Y.	1	3	4	*3.4*
Cambridge, Mass.	30	22	52	*576.8*
Chicago, Ills.	29	16	45	*26.5*
Baltimore, Md.	22	16	38	*74.6*
New Haven, Conn.	24	10	34	*314.7*
Philadelphia, Pa.	14	20	34	*26.3*
Boston, Mass.	14	19	33	*58.8*
Ithaca, N. Y.	17	15	32	*2436.1*
Ann Arbor, Mich.	20	5	25	*1723.1*
Madison, Wis.	7	11	18	*939.2*
Berkeley, Cal.	8	9	17	*1286.5*
Palo Alto, Cal.	9	7	16	*9650.2*
Princeton, N. J.	8	6	14	*3590.6*
Minneapolis, Minn.	3	8	11	*54.3*
St. Louis, Mo.	6	5	11	*19.1*
Worcester, Mass.	7	4	11	*229.6*
Cleveland, O.	6	4	10	*26.2*
Columbus, O.	3	7	10	*79.6*
San Francisco, Cal.	1	9	10	*29.1*
Columbia, Mo.	1	8	9	*1592.6*
Lincoln, Nebr.	4	5	9	*224.0*
Syracuse, N. Y.	0	9	9	*83.0*
Cincinnati, O.	2	6	8	*24.5*
Bryn Mawr, Pa.	2	5	7	*?*
Evanston, Ills.	5	2	7	*363.4*
Middleton, Conn.	2	5	7	*730.0*
Bloomington, Ind.	3	3	6	*928.8*
Brookline, Mass.	4	2	6	*300.9*
Charlottesville, Va.	5	1	6	*930.7*
Iowa City, Ia.	4	2	6	*751.2*
Mt. Hamilton, Cal.	4	2	6	*?*
Northampton, Mass.	2	4	6	*321.8*
Providence, R. I.	5	1	6	*34.2*
Albany, N. Y.	3	2	5	*53.1*
Amherst, Mass.	3	2	5	*994.9*
Chapel Hill, N. C.	3	2	5	*4549.6*
Lawrence, Kans.	2	3	5	*460.3*
New Brunswick, N. J.	2	3	5	*249.9*
Total.	415	367	782	

places had in 1860 a population of about 4,500,000 as compared with a rural population of about 27,000,000. The urban population was about one sixth of the rural population and produced more than a quarter of the scientific men. The urban birth rate was 50 and the rural birth rate was 23.8. The superior position of the towns is doubtless due to a more favorable environment, but it may also be in part due to the fact that the parents of these scientific men were the abler clergymen and others of their generation who were drawn to the cities.

Table III. gives the institutions with which three or more of the scientific men are connected, and in the case of institutions in which there are more than fifteen the details of their rank are shown, I., II., etc., representing the first hundred, the second hundred, etc. I give this table with some hesitation, but it appears that in the end it will be for the advantage of scientific research if it is known which institutions obtain and retain the best men. Harvard has 66.5 of the scientific men, the half (0.5) being used when a professor is emeritus or gives only part of his time to an institution. Columbia follows with 60, and Chicago comes next with 39. In both the U. S. Geological Survey and the Department of Agriculture there are 32. About half of the scientific men are connected with 18 institutions. Harvard has not only the largest number of scientific men, but they are also of the highest rank, 19 being in the first hundred and 8.5 in the second hundred. Johns Hopkins has nine in the first hundred and Columbia and Chicago each has seven. A table such as this might have some practical influence if the data were made public at intervals of ten years.

Table IV. gives the institutions at which the 1,000 men of science pursued their studies. A man is credited for his degree to the first institution at which he took it, but in the case of graduate study, he may have attended several institutions. He is not, however, credited

TABLE III.—DISTRIBUTION ACCORDING TO PRESENT POSITION OF THE THOUSAND MEN OF SCIENCE.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	Total.
Harvard	19	8.5	3	6.5	3.5	6	4.5	5.5	3.5	6.5	66.5
Columbia	7	6	6.5	4.5	5	4.5	5.5	6	4	11	60
Chicago	7	10	3	6	2	2.5	3	2	1.5	2	39
Cornell	3	6	3	2	3	1.5	3	3.5	4	4.5	33.5
U. S. Geological Survey	6	3	4	4	4	1	3	3	2	2	32
U. S. Department Agriculture.	3	4	2	4	3	2	3	3	3	5	32
Johns Hopkins	9	2	5.5	0	1.5	2	4.5	0.5	1	4.5	30.5
California	1	2	2	4	3	4	1	5	1	4	27
Yale	2	5.5	3	3.5	5.5	2	1	0	2	2	26.5
Smithsonian Institution	3	2	4	4	2	0	1	3	1	2	22
Michigan	1	3	6	3	3	0	0	1	1	2	20
Mass. Inst. Tech.	1	2	2.5	4	2	3	2	0	0	3	19.5
Wisconsin	1	3	1	2	0	3	2	4	2	0	18
Pennsylvania	2	1	1	3.5	2.5	1.5	1	2	0.5	2	17
Leland Stanford, Jr.	3	1	1	1	3	2	2	1	1	1	16
Total											459.5
Princeton											14.5
Minnesota, Ohio State											10
New York University											9.5
Missouri, Nebraska, Northwestern											9
National Bureau of Standards, U. S. Navy, Am. Mus. Nat. History											8
Carnegie Institution, Clark, Iowa, Syracuse, Virginia, Wesleyan											7
Bryn Mawr, Cincinnati, Dartmouth, Illinois, Indiana, N. Y. Botanical Garden, Smith											6
Brown, Kansas, North Carolina, Texas, Washington (St. Louis)											5
Field Columbian Museum, General Electric Co., St. Louis, Western Reserve, Pennsylvania State, Rutgers											4
Lehigh											3.5
Philadelphia, Acad. Nat. Sciences Amherst, Case, College of City of New York, Colorado College, Colorado University, Haverford, Purdue, Rockefeller Institute, Simmons, Tufts, Vassar, Worcester...											3
Grand Total											730

TABLE IV. ATTENDANCE OF THE THOUSAND MEN OF SCIENCE AT DIFFERENT INSTITUTIONS.

	Bachelor's Degree.			Graduate Study.			Ph.D.			Grand Total.
	I.-V.	VI.-X.	Total.	I.-V.	VI.-X.	Total.	I.-V.	VI.-X.	Total.	
Harvard	55	51	*106*	38	36	*74*	30	27	*57*	**237**
Johns Hopkins	12	15	*27*	27	15	*42*	50	52	*102*	**171**
Yale	35	17	*52*	9	4	*13*	14	14	*28*	**93**
Columbia	12	16	*28*	9	3	*12*	11	27	*38*	**78**
Cornell	19	12	*31*	4	13	*17*	10	16	*26*	**74**
Michigan	23	12	*35*	4	4	*8*	8	2	*10*	**53**
Princeton	11	12	*23*	5	7	*12*	4	4	*8*	**43**
Chicago	0	2	*2*	3	11	*14*	12	11	*23*	**39**
Mass. Inst. Tech.	13	13	*26*	3	6	*9*	0	0	*0*	**35**
Amherst	12	11	*23*	2	3	*5*	0	1	*1*	**29**
Clark	0	0	*0*	5	11	*16*	4	8	*12*	**28**
Pennsylvania	5	10	*15*	2	2	*4*	3	6	*9*	**28**
Wisconsin	4	10	*14*	1	4	*5*	2	2	*4*	**23**
California	5	7	*12*	3	3	*6*	3	1	*4*	**22**
Wesleyan	9	7	*16*	2	3	*5*	0	0	*0*	**21**
Indiana	4	4	*8*	2	4	*6*	4	0	*4*	**18**
Nebraska	5	5	*10*	4	2	*6*	1	1	*2*	**18**
Williams	6	8	*14*	0	2	*2*	0	1	*1*	**17**
Dartmouth	5	5	*10*	2	1	*3*	0	1	*1*	**14**
Oberlin	6	4	*10*	2	2	*4*	0	0	*0*	**14**
College City N. Y.	7	4	*11*	1	1	*2*	0	0	*0*	**13**
Geo. Washington	3	2	*5*	2	0	*2*	3	3	*6*	**13**
Brown	4	4	*8*	1	2	*3*	0	0	*0*	**11**
Iowa	2	4	*6*	1	2	*3*	1	0	*1*	**10**
Toronto	5	13	*18*	3	3	*6*	0	0	*0*	**24**
Edinburgh	2	1	*3*	0	3	*3*	2	3	*5*	**11**
Cambridge	2	0	*2*	3	5	*8*	0	0	*0*	**10**
Berlin				53	42	*95*	11	11	*22*	**117**
Leipzig				30	15	*45*	27	12	*39*	**84**
Göttingen				18	18	*36*	19	14	*33*	**69**
Heidelberg				27	14	*41*	7	8	*15*	**56**
Munich				13	5	*18*	6	7	*13*	**31**
Strasburg				13	4	*17*	3	3	*6*	**23**
Freiburg				10	5	*15*	3	1	*4*	**19**
Bonn				10	4	*14*	2	2	*4*	**18**
Zürich				5	6	*11*	1	2	*3*	**14**
Vienna				9	3	*12*	0	0	*0*	**12**
Würzburg				4	3	*7*	3	2	*5*	**12**
Paris				21	7	*28*	0	1	*1*	**29**
Total	**266**	**249**	**515**	**351**	**278**	**629**	**244**	**243**	**487**	**1631**

as a graduate student to the institutions from which he received the doctorate.[2] The total influence of Harvard is 237, of the Johns Hopkins 171, of Yale 93, of Columbia 78 and of Cornell 74. About one tenth of the men of science received their bachelor's degree from Harvard and about the same number their doctor's degree from the Johns Hopkins. It is not certain that a preponderance of scientific men has been produced at any institution as compared with the total number of students, and it appears that those who attend the larger universities are not of higher average performance than others. Thus of the 106 who have taken the bachelor's degree at Harvard, 55 are in the first rank and 51 in the second. Yale, Cornell and Michigan have produced men above the average rank, and the excess is such that it is probably significant, though the departures fall within the limits of possible chance variation. On the whole,

[2] The doctorates include the comparatively few cases in which the degree of doctor of science has been conferred in course.

however, there is no significant difference in rank between the 515 men who attended the larger institutions and those who attended smaller colleges or none. It might be supposed that abler students would be attracted to a university such as Harvard, and that they would have greater opportunities there, but this appears not to be the case. So far as it goes, this favors the theory that men of science are born such and are not dependent on the environment for the quality of their performance. It may, however, be that relatively more men of mediocre ability are led to take up scientific work at an institution such as Harvard, whereas only those of genius are likely to break through the barrier of an unfavorable environment.

The conditions are similar in the case of the doctor's degree. Of the 487 men who have received it from the larger institutions, 244 are of the first rank and 243 of the second; nor do any institutions excel, unless it be Leipzig and Göttingen. Those who pursue graduate studies at institutions from which they do not take the degree are of distinctly higher standing than the average A.B. or Ph.D. This is probably because the abler and more energetic men have attended several institutions, more especially abroad, many of them having worked in foreign universities even after having obtained scientific distinction.

The thousand men of science under consideration pursued their graduate studies on the average from fifteen to twenty years ago. Since that time a considerable change has occurred in the relative numbers of students attracted to different institutions. Owing to the improvement of our universities relatively fewer students now frequent foreign institu-

TABLE V. SUBJECTS OF THE THOUSAND MEN OF SCIENCE WHO HAVE PURSUED GRADUATE STUDIES OR TAKEN THE DOCTOR'S DEGREE AT DIFFERENT INSTITUTIONS.

	Graduate Study.													Ph.D.											Grand Total.
	Chemistry	Physics.	Zoology.	Geology.	Botany.	Mathematics.	Pathology.	Psychology.	Astronomy.	Physiology.	Anatomy.	Anthropology.	Total.	Chemistry.	Physics.	Zoology.	Geology.	Botany.	Mathematics.	Pathology.	Psychology.	Astronomy.	Physiology.	Anatomy.	Anthropology.	Total.	
Johns Hopkins	3	8	5	4	3	5	7	2		3	2		*42*	18	24	22	9	1	8	1	6	2	10	1		*102*	144
Harvard	10	8	13	8	12	10	1	7	1	3	1		*74*	9	2	20	7	10	3		4		2		2	*57*	131
Columbia	3	4		2		1		1		1			*12*	5	5	9	1	5	6		2	2	2		1	*38*	50
Cornell	1	4	3	2	3	2				1	1		*17*	1	14	2		5	1		3					*26*	43
Yale	3	2	2	4		1		1					*13*	8	2	2	5	1	5		2	1	2			*28*	41
Chicago	2	4	1		3		1		2	1			*14*	1	1	11	3	2	3				1	1		*23*	37
Clark	1	2	6			5				1	1		*16*		1	2			1	1	5		1		1	*12*	28
Princeton		1	6			1		2	1		1		*12*	1	3	2			1		1					*8*	20
Michigan		4	2			1		1					*8*		2	1		4		3						*10*	18
Pennsylvania			1				2	1					*4*	3	1	3		1			1					*9*	13
California	1	1	1					1	2				*6*	1			1	2								*4*	10
Indiana		2	1		1			2					*6*			2	1	1								*4*	10
Berlin	18	24	5	3	5	5	10	14	3	4	3	1	*95*	3	12	1			2		1	3				*22*	117
Leipzig	10	2	7	3	2	4	2	8		5	1	1	*45*	11	2	8	1	3	4		9		1			*39*	84
Göttingen	10	5	1	3		9	3	5					*36*	17	2		2		12							*33*	69
Heidelberg	18	2	2	8		3	2	4		1		1	*41*	12			3									*15*	56
Munich	10		2	2			1	1		1	1		*18*	5		1	3	2				1	1		.	*13*	31
Strasburg	4	1	4		2	1	2		2		1		*17*		2	1		1	1				1			*6*	23
Freiburg	3	1	5	1			2	2		1			*15*	1		2					1					*4*	19
Bonn	2				7			1	1	2		1	*14*		1			2	1							*4*	18
Zürich	6	3	1			1							*11*	2				1								*3*	14
Vienna	1	1					10						*12*													*0*	12
Würzburg	2		3				1				1		*7*		4	1										*5*	12
Paris	5	4	3	3		4	3	6					*28*						1							*1*	29
Total	113	83	74	43	38	58	47	59	12	24	13	4	563	98	78	90	36	41	49	5	35	10	18	2	4	466	1029

tions. The number of doctorates conferred in the natural and exact sciences during the past nine years is as follows: Johns Hopkins, 147; Chicago, 145; Columbia, 137; Harvard, 129; Yale, 120; Cornell, 94; Pennsylvania, 85; Clark, 75. There is then a drop to universities that have conferred fewer than 25 degrees in the sciences during this period. Relatively more work is done in the sciences in some institutions than in others. Thus the percentage of degrees in the sciences in these universities is as follows: Clark, 95; Cornell, 58; Johns Hopkins, 54; Columbia, 49; Chicago, 48; Pennsylvania, 43; Harvard, 42, and Yale, 41.

Table V. shows the institutional origin of men who have pursued different sciences. The Johns Hopkins University has excelled relatively in chemistry, physics, zoology and physiology; Harvard in zoology and botany; Columbia in zoology, botany and mathematics; Cornell in physics and botany; Clark in psychology, and Michigan in botany and pathology. Of the foreign universities, Berlin has excelled in physics, Leipzig in psychology and Göttingen in chemistry and mathematics.

The table also shows that men are more likely to pursue graduate studies and to take the doctor's degree in some sciences than in others. Of the fifty psychologists, 35 have received the doctor's degree from the institutions given in the table, and of the 150 zoologists 90 have received it, whereas only two of the 25 anatomists and only five of the 60 pathologists have received a non-technical higher degree from these universities. While important improvements in the practise of surgery and medicine have been made in this country, it must be admitted that we are not doing our share for the advancement of pathology, anatomy and physiology.

It would be desirable to compare the scientific men and the scientific work of the United States with those of other nations, and I hope to collect data on this subject. It is my impression from such information as is on hand that we produce from one seventh to one tenth of the world's scientific research, but that we have not produced one tenth of its recent great discoveries or of its contemporary great men. With our vast population and unlimited resources, it would be shameful and intolerable to let the future be no better than the present. It is obvious that we should collect without delay the information that would tell us where we stand among the nations.

It is not altogether without interest to find that it is possible to reduce to order facts which might be supposed to be outside the range of the natural and exact sciences. The present articles are, however, only a beginning of a study of scientific men as a group and of the conditions on which scientific performance depends. We have in a large measure explored the material world and subdued it to our uses; it is now our business to secure an equal increase in our knowledge of human nature and to apply it for our welfare. If he is a benefactor to mankind who makes two blades of grass grow where one grew before, his services would be immeasurably greater who could enable two men of science to flourish where there had been but one.

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Brachiopod Nomenclature.

The following is an epitome of the results of some recent investigations; a fuller account of them has been handed to the editor of the *Annals and Magazine of Natural History* (England).

The genera *Epithyris*, *Hypothyris* and *Cleiothyris* can not be used, as they are now, on King's authority: they must stand or fall by what Phillips did. From what Phillips says of the first two (Pal. Foss. Devon., etc., 1841, pp. 54, 55) the types are as follows:

Genus *Epithyris*, Phillips.

Type *Terebratula maxillata*, Sowerby.

This will be the generic name for the *Terebratula maxillata* group of the Jurassic.

Genus *Hypothyris*, Phillips.

Type *Terebratula concinna*, Sowerby.

This would be the name for a series of Jurassic Rhynchonellæ, but it is preoccupied, and so must drop altogether. However, the terms epithyrid and hypothyrid will be found extremely useful to describe the beak-characters which Phillips noted.

Genus *Cleiothyris,* Phillips.

Type *Terebratula concentrica,* von Buch.

The type here is not so certain; but this seems to be the solution of Phillips's rather ambiguous phrases. At any rate *Cleiothyris* can not be used as King intended.

The genus *Seminula* has hitherto been incorrectly used, with *Spirifer ambiguus* as type, on a doubtful identification of Davidson's—that *T. pentaëdra,* the true genotype, was a synonym of *S. ambiguus.* But *T. pentaëdra* is hypothyrid, that is, it has a rhynchonelliform beak; while *S. ambiguus* is epithyrid, that is, it has a terebratuliform beak. *T. pentaëdra* is what would at present be called a *Camarophoria. S. ambiguus* happens to have been taken as type of a genus *Composita* in 1845, but it has always been overlooked. Therefore—

Genus *Seminula,* McCoy.

Type *Terebratula pentaëdra,* Phillips.

Non *Seminula,* auct.

The genus is not of the family Athyridæ, but is a pentamerid, allied to the later named *Camarophoria,* which may, perhaps, be retained for the transverse multiplicate forms, *Seminula* designating the globose pauciplicate species.

Genus *Composita,* Brown.

Type *Spirifer ambiguus,* Sowerby.

Syn. *Seminula,* auct. non McCoy.

Ref. T. Brown, 'Illustr. Fossil Conch. G. Britain and Ireland,' p. 131, 1845. This work of Brown's has been altogether neglected, and his names overlooked; but he was quite definite about his type. His work appeared in parts from 1837 to 1849; and the date of p. 131 is 1845. (*Vide,* Sherborn, Proc. Malacol. Soc., VI., 358, 1905.) All the athyrids hitherto assigned to *Seminula* will have to bear the name *Composita.*

Genus *Leptodus,* Kayser.

Syn. *Lyttonia,* Waagen.

Leptodus is generally given as a synonym of *Lyttonia;* but Waagen was not justified in suppressing Kayser's name merely because he placed it among fishes.

Genus *Cyclothyris,* McCoy.

Type, the species figured by McCoy, 'Carb. Foss.,' p. 150, fig. 29 = *Terebratula latissima,* Sowerby.

Davidson made this suggestion, and it appears correct. Therefore, the bulk of the Mesozoic Rhynchonellæ—all those that are multiplicate and hypothyrid—should go under this genus rather than under *Rhynchonella,* which should be applied only to the species congruous with the *R. loxia* series of pauciplicate hypothyrids.

New names are required for *Hypothyris,* auct. non Phillips and *Cleiothyris,* auct. non Phillips. The following were suggested: *Hypothyridina,* vice *Hypothyris,* and *Cleiothyridina,* vice *Cleiothyris.*

S. S. BUCKMAN.

CURRENT NOTES ON METEOROLOGY.

THE CYCLONIC THEORY.

To the interesting discussion concerning temperatures in cyclones and anticyclones, H. H. Clayton contributes an article in the *Beiträge zur Physik der freien Atmosphäre,* Vol. II., No. 2, on 'A Discussion of the Observations obtained by the Blue Hill Observatory with Ballons-sondes at St. Louis.' As the readers of these notes are aware, this discussion has been going on for some time, and has been participated in chiefly by Hann, Clayton and Bigelow. To go into the details as each article appeared has always seemed to the compiler of these notes too technical a matter for the columns of a general scientific journal like SCIENCE, and to do so would have occupied a good deal more space than could be devoted to meteorology in this publication. We are glad to note the emphasis which Mr. Clayton lays upon the points upon which general agreement has been reached, for further discussion will be more helpful and more to the point if the matters which have found general acceptance are clearly established. To quote: "The results of all the investigators agree in showing that the highest temperatures at all heights within an area of low pressure are in advance of the barometric minimum and the lowest in the rear; while in the area of high pressure the lowest temperature is in advance of the barometric maximum and the highest

in the rear." This conclusion, Mr. Clayton believes, "will probably find general acceptance as representing the conditions up to 6 kms. everywhere in temperate latitudes." In answer to a criticism made by Hann (*Met. Zeitschr.*, Nov., 1905, 491) to the effect that Mr. Clayton had determined the central areas of cyclone and anticyclone from the time of high and low pressure at Blue Hill, and not from the weather maps, our author points out that the weather maps were used. We ourselves carelessly omitted to point out that Dr. Hann was mistaken in his objection, on the occasion of our mention of this matter in these notes some months ago.

CLIMATOLOGICAL ATLAS OF INDIA.

One of the most attractive, as well as one of the most important publications in climatology ever issued is the new 'Climatological Atlas of India,' prepared by Sir John Eliot, lately meteorological reporter to the government of India, and published by Bartholomew, of Edinburgh. This atlas contains one hundred and twenty colored maps, showing with great detail and in well-selected, harmonious colors, the distribution of the climatic elements over the Indian empire. We learn from the preface that a handbook of the weather and climates of India is in preparation and will be a companion volume to the atlas. India has for many years been well known for its admirable meteorological service and for its long series of valuable meteorological publications. Sir John Eliot has now fittingly ended his term of service as head of that organization by preparing this magnificent volume which will always stand as a monument to his work.

MONTHLY WEATHER REVIEW.

The last number of the *Monthly Weather Review* (No. 6, 1906) contains an illustrated paper by Professor J. E. Church, Jr., of the University of Nevada, on the new 'Mount Rose Weather Observatory,' in Nevada; a plea for the 'Use of the Lantern in Teaching Meteorology,' by Professor J. P. Goode, of the University of Chicago; a further instalment of his 'Studies on the Thermodynamics of the Atmosphere,' by Professor F. H. Bigelow; a description of a waterspout near Tarrytown, N. Y., July 16, 1904, illustrated by six half-tones; an account of 'The Tornado of June 6, 1906, near La Crosse, Wis.,' by G. A. Oberholzer, and of 'The Tornado of April 12, 1906, at Stafford, Kansas,' by W. E. Seright; and several short papers on 'The Structure of Hailstones.'

NOTES.

Professor W. I. Milham has published a 'Syllabus of a Course on Meteorology,' given by him in Williams College. The course is a three-hour elective for juniors and seniors, and is much more thorough than most of the courses at present being given in American colleges. Practical work in making observations, in generalizing from meteorological data and in making forecasts, is required as part of the course.

Ciel et Terre for September 1, 1906, contains articles on the dust from Vesuvius observed at Brussells last spring, and on atmospheric waves noted at the observatory of Meudon, by Millochau, by means of the telescope.

The Annual Report of the Transvaal Meteorological Department for the year ending June 30, 1905, contains several charts showing the distribution of the various meteorological elements; also half-tones of lightning views taken at Vereeniging in 1904–5.

R. DeC. Ward.

RECENT IMPORTANT ANTI-MALARIA WORK.

The latest reports on the measures taken to abolish malaria from Klang and Port Swettenham in Selangor, Federated Malay States, indicate the most admirable results. These measures were undertaken first in 1901 and 1902, and have been reported upon from time to time in the *Journal of Tropical Medicine*. The expenditure undertaken by the government with a view to improving the health of the inhabitants of these towns has been fully justified by the results which promise to be of permanent value. The total expenditure for the town of Klang, down to the end of 1905 was £3,100, and the annual permanent expenditure is about £60 for clearing earth

drains and £210 for town gardeners. For Port Swettenham the total expenditure to the end of 1905 was £7,000 and the annual cost of keeping up the drains, etc., is approximately £40 for clearing earth drains and £100 for town gardeners.

The careful tabulation of cases and deaths and of the results of the examination of blood of children in especially drained areas indicate the following conclusions: (1) Measures taken systematically to destroy breeding places of mosquitoes in these towns, the inhabitants of which suffered terribly from malaria, were followed almost immediately by a general improvement in health and decrease in death rate. (2) That this was due directly to the work carried out and not to a general dying out of malaria in the district, is clearly shown by figures pointing out that while malaria has practically ceased to exist in the areas treated it has actually increased to a considerable extent in other parts of the district where anti-malaria measures have not been undertaken.

The statistics for 1905 are even more favorable than those for 1902, which gives a very strong evidence in favor of the permanent nature of the improvement carried out. In fact, it seems as though malaria has been permanently stamped out at Klang and Port Swettenham by work undertaken in 1901, and this experience in the Malay States should be of value to those responsible for the health of communities similarly situated in many other parts of the world.

Another striking example of excellent work of this kind is found in the recently published report on the suppression of malaria in Ismailia, issued under the auspices of the Compagnie Universelle du Canal Maritime de Suez. Ismalia is now a town of 8,000 inhabitants. It was founded by DeLesseps in April, 1862, on the borders of Lake Timsah, which the Suez Canal crosses at mid-distance between the Red Sea and the Mediterranean. Malarial fever made its appearance in very severe form in September, 1877, although the city had up to that time been very healthy, and increased so that since 1886 almost all of the inhabitants have suffered from the fever. In 1901 an attempt to control the disease was made on the mosquito basis, and this attempt rapidly and completely succeeded, and after two years of work all traces of malaria disappeared from the city. The work was directed not only against anopheles mosquitoes, but against other culicids, and comprised the drainage of a large swamp and the other usual measures. The initial expense amounted to 50,000 francs, and the annual expenses since have amounted to about 18,300 francs.

The results may be summarized about as follows: Since the beginning of 1903 the ordinary mosquitoes have disappeared from Ismailia. Since the autumn of 1903 not a single larva of anopheles has been found in the protected zone, which extends to the west for a distance of one thousand meters from the first houses in the Arabian quarter and to the east for a distance of 1,800 meters from the first houses in the European quarter. After 1902 malarial fever obviously began to decrease, and since 1903 not a single new case of malaria has been found in Ismailia.

Last May Dr. Ronald Ross, of the Liverpool School of Tropical Medicine, to whom the writer is indebted for information concerning these instances just cited, was asked by the Lake Kopais Company in Greece to make a study of the malaria which has long been prevalent on their estates in that part of Greece. He made the trip and carried out the investigation which revealed an unexpectedly high degree of malarial infection in most of the localities examined. He also learned from members of the Grecian Anti-malaria League that the district of Kopais is by no means exceptional in this respect, and that malaria is very prevalent in many rural areas throughout the country.

As an example of the conditions, Dr. Ross found that in the village of Moulki, near the ancient Heliartos on the Kopaic Plain, of eighty persons examined, in thirty-eight there was an enlargement of the spleen—nearly fifty per cent.; at the village of Mazi he found it in thirteen cases out of forty; at Skripou (the ancient Orchomenos) it occurred in twenty-five out of fifty school children—exactly fifty per cent. He suggests the query as to how

far malaria has influenced the past history and the modern development of Greece, and shows that the regions maintaining most of the rural population are the ones most seriously affected—in fact, a vigorous country life can not exist under the conditions found. Where villages, churches, inns and country houses should be scattered about the landscape, the villages are few and poor and country houses are almost entirely absent.

The Antimalarial League of Greece, of which H. M. the King of Greece is patron, has already commenced work against malaria, and appeals for help to all those interested. The Liverpool School of Tropical Medicine has published an appeal for subscriptions, and H. R. H. Princess Christian has consented to be the patroness of the subscription in Great Britain. Subscriptions may be paid to the secretary of the Liverpool School of Tropical Medicine, B 10 Exchange Buildings, Liverpool, England.

So many excellent and most practical and convincing evidences of the possibility of the extermination of malaria are now culminating that it is obvious not only that with a certain expenditure of money the disease can be wiped out in a country like Greece, but that in our own territory the question is simply one of funds and an enlightened public spirit.

L. O. Howard.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

The American Association for the Advancement of Science and the national scientific societies named below will meet in New York City during convocation week, beginning on December 27, 1906.

American Association for the Advancement of Science.—December 27–January 1. Retiring president, Professor C. M. Woodward, Washington University, St. Louis, Mo.; president-elect, Professor W. H. Welch, The Johns Hopkins University, Baltimore, Md.; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Dr. John F. Hayford, U. S. Coast and Geodetic Survey, Washington, D. C.; secretary of the council, President F. W. McNair, Houghton, Mich.

Local Executive Committee.—J. J. Stevenson, chairman, C. C. Adams, Charles Baskerville, Franz Boas, N. L. Britton, H. C. Bumpus, Chas. A. Conant, Simon Flexner, Wm. J. Gies, Wm. Hallock, Alex. C. Humphreys, G. S. Huntington, Edward Kasner, Henry F. Osborn, C. L. Poor, Clifford Richardson, E. B. Wilson, Frederick J. E. Woodbridge, J. McKeen Cattell, secretary.

Section A, Mathematics and Astronomy.—Vice-president, Professor Edward Kasner, Columbia University; secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor W. C. Sabine, Harvard University; secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Mr. Clifford Richardson, New York City; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Mr. W. R. Warner, Cleveland, O.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Dr. A. C. Lane, Lansing, Mich.; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Professor E. G. Conklin, University of Pennsylvania; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president Dr. D. T. MacDougal, Washington, D. C.; secretary, Professor F. E. Lloyd, Desert Botanical Laboratory, Tucson, Arizona.

Section H, Anthropology.—Vice-president, Professor Hugo Münsterberg, Harvard University; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Mr. Chas. A. Conant, New York City; secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Dr. Simon Flexner, The Rockefeller Institute for Medical Research; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

The American Society of Naturalists.—December 28. President, Professor William James, Harvard University; secretary, Professor W. E. Castle, Harvard University.

The Astronomical and Astrophysical Society of America.—December 27. President, Professor E. C. Pickering, Harvard College Observatory; secre-

tary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—President, Professor Carl Barus, Brown University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Mathematical Society.—December 28, 29. President, Professor W. F. Osgood, Harvard University; secretary, Professor F. N. Cole, Columbia University.

The American Chemical Society.—December 27–January 2. President, Professor W. F. Hillebrand, U. S. Geological Survey; secretary, Dr. William A. Noyes, the Bureau of Standards, Washington, D. C.

The Geological Society of America.—December 26–29. Acting president, Professor W. M. Davis, Harvard University; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

The Association of American Geographers.—December 31–January 1. President, Cyrus C. Adams, New York City; secretary, Albert P. Brigham, Colgate University.

The American Society of Zoologists.—December 27, 28, 29. President (Eastern Branch), Professor W. E. Castle, Harvard University; secretary, Professor H. S. Pratt, Haverford College. President (Central Branch), Professor C. C. Nutting, University of Iowa; secretary, Professor T. G. See, University of Michigan.

The Association of Economic Entomologists.—December 28, 29. President, A. H. Kirkland, Malden, Mass.; secretary, A. F. Burgess, Columbus, O.

The Society of American Bacteriologists.—President, Dr. E. F. Smith, U. S. Department of Agriculture; secretary, Professor S. C. Prescott, Massachusetts Institute of Technology.

The American Physiological Society.—December 27, 28, 29. President, Professor W. H. Howell, the Johns Hopkins University; secretary, Professor Lafayette B. Mendel, 18 Trumbull St., New Haven, Conn.

The Association of American Anatomists.—December 27, 28, 29. President, Professor Franklin P. Mall; secretary, Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

The Botanical Society of America.—December 27, 28, 29. President, Dr. F. S. Earle; secretary, Dr. William Trelease, Missouri Botanical Garden, St. Louis, Mo.

The American Psychological Association.—December 27–28. President, Professor James R. Angell, University of Chicago; secretary, Professor Wm. Harper Davis, Lehigh University.

The American Philosophical Association.—December 27–29. President, Professor William James, Harvard University; secretary, Professor John Grier Hibben, Princeton University.

The American Anthropological Association.—December 27–January 3. President, Professor F. W. Putnam, Harvard University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—December 27–January 3. President, Dr. A. L. Kroeber, University of California; secretary, W. W. Newell, Cambridge, Mass.

New York State Science Teachers Association.—December 26, 27. President, John F. Woodhull, Teachers College, Columbia University.

SCIENTIFIC NOTES AND NEWS.

DR. HENRY FAIRFIELD OSBORN, Da Costa professor of zoology in Columbia University, curator of vertebrate paleontology and vice-president of the American Museum of Natural History, geologist and paleontologist of the U. S. Geological Survey, has been elected secretary of the Smithsonian Institution to succeed the late Samuel Pierpont Langley.

THE Botanical Society of America (a union of the Botanical Society of America, the Society for Plant Morphology and Physiology and the American Mycological Society) will hold its first meeting, under the federation effected last winter, in New York City, during convocation week. The council will meet at 9 A.M. on Thursday, in Schermerhorn Hall, and a very important business session will be held in the same place at 11 o'clock the same morning. Scientific meetings will be held at Schermerhorn Hall on Friday afternoon, and at the Botanical Garden both morning and afternoon on Saturday. It is also possible that sessions may be held on the following Monday. Professor F. S. Earle, of Herradura, Cuba, is president and Dr. Wm. Trelease, of St. Louis, is secretary.

THE American Physiological Society will meet, as already announced, on December 27, 28, 29 in New York City. The meetings will be held on December 27 in the physiological laboratories of the University and Bellevue Hospital Medical College, 338 East 26th St.; on December 28 in the physiological laboratories of the College of Physicians and Surgeons, 437 West 59th St.; on December 29, joint meeting with Section K of the American Association for the Advancement of Science in the Rockefeller Institute for Medical Research, 66th St. and Avenue A. All communications should be addressed to the secretary,

Professor Lafayette B. Mendel, 18 Trumbull St., New Haven, Conn.

Emeritus Professor Campbell Fraser was presented on November 6, by the senatus and former pupils, with addresses of congratulation on the occasion of his jubilee as professor of logic and metaphysics in the University of Edinburgh. The principal, Sir William Turner, presided over a large representation of the senatus, and the class room was filled with the general public and students.

Dr. August Tobler, docent in paleontology at Basle, will make an expedition to the East Indies, lasting several years.

Dr. E. Grosse, associate professor of ethnology at Freiburg, has received leave of absence to carry on researches in east Asia.

The fourth lecture in the Harvey Society course was delivered by Professor J. G. Adami, of McGill University, Montreal, on December 1, at 8:30 P.M., at the New York Academy of Medicine. Subject: 'The Myelins and Potential Fluid Crystals of the Body.'

At its annual dinner, on November 21, the Society of Ex-Internes of Kings County Hospital, Brooklyn, presented to the hospital association a bronze memorial tablet in memory of the late Walter Reed, who was an interne there in 1871, prior to his entrance into the medical department of the United States Army.

A marble bust of Dr. Wilhelm Hittorf has been placed in the physical laboratory of Münster University, on the occasion of the celebration of the fiftieth anniversary of his doctorate.

Major Horatio N. Rust, noted both for his work on behalf of the Indians of southern California and for his archeological and ethnological collections and publications, died at South Pasadena, California, on November 14.

Dr. von Rothmund, professor of ophthalmology in the University of Munich, has died at the age of sixty-eight years.

The Rev. Dr. Johannes Dzierzon, known for his studies on bees, has died at the age of ninety-five years.

The U. S. Civil Service Commission announces the postponement, to January 3–4, 1907, of the examination scheduled for December 5–6, to fill at least four existing vacancies and vacancies as they may occur in the position of aid in the Coast and Geodetic Survey, at $720 per annum. A vacancy as computer at $1,400 to $1,800 per annum, according to experience, and one as draftsman, at $1,400 to $1,800, according to experience, both in the service of the Coast and Geodetic Survey at Manila, P. I., may also be filled from the eligibles resulting from this examination, provided suitable eligibles are secured. As the commission has experienced considerable difficulty in securing a sufficient number of eligibles for this position to meet the needs of the service, qualified persons are urged to enter this examination. There will also be a civil service examination on December 12, to fill a vacancy in the position of assistant in animal husbandry in the Bureau of Animal Industry, Department of Agriculture, at $1,800 per annum.

Among the New York State civil service examinations in December is one of chemist in the Department of Agriculture at a salary of $1,200. The examination will have special reference to the analysis of food and dairy products.

A Seismological Society has been formed in California. The letter calling a preliminary meeting says: "The formation of such a society would seem to be both proper and opportune. The fact that the Pacific coast has been the center of much seismic activity, and that the city of San Francisco has now a historic interest in matters seismological, may be offered as valid reasons why this section of our country should take the initiative in the formation of such an organization. The State Earthquake Commission is on record as favoring the formation of a seismological society. Several earnest investigators, including Dr. Omori, who recently visited the coast, have urged that organized effort be attempted through such a society, to collect, preserve and utilize all records, reports and studies of seismic phenomena. The prime object of such an organization as in Japan should be to

mold public opinion, to advise wisely, to set forth the truth and to provide funds for research and investigation. It is expected that such a society will be able, with the funds entrusted to its care, to publish from time to time the best information obtainable concerning earthquakes, and in every way work for the benefit and welfare of not only our own community but all mankind, so far as the effects of earth movements are concerned."

THE second meeting of the Southern Society for Philosophy and Psychology will be held in Montgomery, Alabama, in connection with the Southern Educational Association, December 27–29. Further particulars will be given later.

MR. LESTER F. WARD would be glad to be informed of as many as possible of the native plants, especially trees and shrubs, of the country which possess the sympodial type of branching, either complete or partial. Names, lists, notes, etc., may be sent to him at Brown University, Providence, R. I. Observations of sufficient importance might be sent to SCIENCE for publication. Any estimates of the proportion of sympodial to monopodial plants would be of interest. The subject is a neglected one, and references to the best treatment of it would be useful.

IN an interesting and well-written article on 'The Lure of the Pearl' in the November *Century*, Mr. Frederick Courtland Penfield has this amusing bit of zoology: "It should be known that the pearl-bearing oyster of the Indian Ocean is only remotely related to the edible variety of America and Europe. It is the *Margaritifera vulgaris*, said to belong to the animal kingdom, and not to the fish family, and is never eaten."

WE learn from *The Journal of Experiment Stations* that the Chinese government has approved a request made by the native board of commerce at Peking for the use of the Loshan garden, which is situated on the Imperial Road outside of the Hsichih Gate of Peking, with an area of 166⅔ acres, as a field for agricultural experiments. In 1905 the board was authorized to take measures for the encouragement of agriculture, but up to the present, with the exception of the few experimental fields and agricultural schools established in Chihli, Shantung, Shansi, Honan and Fukien, little has been done along this line.

THE *Journal of the American Medical Association* states that the Berlin Academy of Sciences has been examining the rich material of ancient medical MSS. in its library, and has just published the first volume of a descriptive catalogue, devoted to works dealing with Hippocrates and Galen. The work has been in charge of Professors H. Diels and G. Schöne. After the complete catalogue is issued it is proposed to publish all the MSS. in full. Professor Heiberg, of Copenhagen, is to help in this task, especially with the Egyptian papyri.

THE Medical Relief Committee, representing the New York Academy of Medicine, and the Medical Societies of the counties of New York and Richmond, announces that the total sum transmitted to the Medical Relief Committee at San Francisco amounted to $7,701.10.

THE daily papers state that 'broadly speaking, the northern hemisphere will after November 1 report daily on its weather conditions to the Weather Bureau in Washington.' An arrangement made with the Central Physical Observatory at St. Petersburg enables reports to be received from the great land area lying between the Russian capital and the Pacific, while the opening of cable communication with Iceland will render possible telegraphic reports of the area of low winter barometer of the North Atlantic. As a consequence of these additional services, it is hoped that the bureau will be in a position to deal with world conditions and to make accurate forecasts for a longer time than ever before.

WE learn from *Nature* that the board of directors of the great manufacturing firm of Kynoch (Ltd.) has decided to introduce the metric system of weights and measures into all their works. A small committee has been appointed to consider the details of the change and to provide the necessary instruments, and

as soon as the committee reports the change will be made. All the weights and measures used by the firm, whether lineal, square or cubic, will be metric. For money calculations the pound sterling will be adopted as the unit, and this will be subdivided decimally.

The Wisconsin Natural History Society announces the following series of nine public lectures to be given during the season of 1906–7 at the Public Museum, Milwaukee. This society is one of the oldest of its kind in the west, having been founded in 1857. At the May meeting the fiftieth anniversary of its foundation will be celebrated.

October 25.—Dr. R. M. Strong, University of Chicago, 'Colors of Birds.' (Illustrated by stereopticon.)

November 22.—Dr. E. C. Case, Wisconsin State Normal School, 'Geological Development of Scenery.' (Illustrated by stereopticon.)

December 20.—Professor C. O. Whitman, University of Chicago, 'The Origin of Species.' (Illustrated by charts.)

January 31.—C. T. Brues, Milwaukee Public Museum, 'The Rôle Played by Insects in the Transmission of Certain Diseases of Man and the Higher Animals.' (Illustrated by stereopticon.)

February 28.—Professor S. W. Williston, The University of Chicago, 'The Phylogeny of the Elephant.' (Illustrated by stereopticon.)

March 28.—Dr. S. Graenicher, Milwaukee, 'The Adaptive Coloration of Insects.' (Illustrated by steropticon.)

April 25.—H. L. Ward, Milwaukee Public Museum, 'Museum Collecting.' (Illustrated by stereopticon.)

May 30.—The Fiftieth Anniversary of the Founding of the Society.—C. H. Doerflinger will give a brief sketch of the founding of the society, followed by Professor E. A. Birge, The University of Wisconsin, 'Science and the People.'

June 27.—I. N. Mitchell, Wisconsin State Normal School, 'Burbank's Work with Plants.' (Illustrated by stereopticon.)

Professor A. R. Crook, curator of the Illinois State Museum of Natural History, announces that a course of popular lectures on natural history and travel will be given in the Arsenal Auditorium on Saturday evenings at eight o'clock as follows:

December 1.—A. R. Crook, Ph.D., Curator, Illinois State Museum of Natural History, 'The Making of the Grand Canyon of the Colorado.' (Illustrated.)

December 8.—O. C. Farrington, Ph.D., Curator of Geology, Field Columbian Museum, 'American Caverns.' (Illustrated.)

December 15.—H. G. Keppel, Ph.D., Northwestern University, 'Holland and the Hollanders.' (Illustrated.)

January 12.—Chas. F. Millspaugh, Ph.D., Curator of Botany, Field Columbian Museum, 'Japan Resourceful.' (Illustrated.)

January 19.—Professor S. W. Parr, University of Illinois, 'What is Coal?' (Illustrated.)

January 26.—H. Foster Bain, Ph.D., State Geologist, 'Origin of Fuels.'

The Educational Times states that an important international inquiry into the methods and results of moral training in schools at home and abroad has been initiated in London. It is proposed to institute an inquiry, conducted by trained investigators, who will visit many European countries, the United States and Japan, to ascertain the conclusions which the best authorities in the different countries have reached as the outcome of their recent efforts. It is hoped to complete this inquiry and to publish the reports of the investigators by the autumn of 1907. The committee, which it is desired to strengthen by the admission of many more distinguished names, already includes, among others, the Bishops of Ripon, Hereford and Stepney, Sir Edward Fry the Right Hon. A. Dyke Acland, former minister of education, Sir Oliver Lodge, the Rev. J. B. Paton, D.D. (of Nottingham), Mr. Harrold Johnson, Secretary of the Moral Instruction League and Professor M. E. Sadler, LL.D., who is acting as hon. secretary at 8 Buckingham Street, Strand, W. C.

The Copenhagen correspondent of the *Medical Record* writes: "Dr. Schaldemose will be appointed successor to Professor Wanscher, who died six months ago. The competition has been very close, not less than eight of our most prominent younger surgeons having entered it. Each competitor had to publish a work of no small size on a surgical topic of his own choosing and to deliver a clinical lecture with three hours' preparation. Three of the competitors, Drs. P. N. Hansen, Lendorf, and Schaldemose, were then admitted to the

final trials, consisting in a lecture on a surgical theme, the same for all of them, and communicated to them twenty-four hours in advance. It is generally reported that the judges found it very difficult to decide which of the three mentioned surgeons was most qualified to succeed to the disputed chair."

ACCORDING to *Nature* the promise of an interesting and useful addition to the local museums in the London district has been furnished by the spirited action of the Tottenham Local Board. In 1892 the Board purchased the fine 'Queen Anne' mansion known as Bruce Castle from Mr. Joshua Pedley at the price he had given for it, 15,000*l.*, toward which sum he contributed 700*l.*, in the hope that some day the house would become the home of a museum for Tottenham. The estate included twenty acres of garden and timbered land, which was soon thrown open as a public park. The idea of a museum having been grasped, many specimens and offers of aid came in from neighbors and friends. By gift, and as a result of a public subscription, several important collections were acquired. Especially worthy of mention are the long series of birds, small mammals and insects in cases and cabinets, made by Mr. H. W. Roberts, formerly a resident in Tottenham; a collection of minerals and fossils formed by Mr. Penstone, a friend of John Ruskin; and the collections of fossils and wax models made and lent by Mr. H. E. H. Smedley. Mr. Smedley is acting as honorary curator, and has generously devoted much time and skill to getting the collections into a fit state for public exhibition. Other important gifts have been made by Mr. C. C. Knight, the Hon. Walter Rothschild, Mr. Ruck, Mr. Currie, and others. The museum was publicly opened by Mr. W. W. Lewin, chairman of the libraries committee, and Councillor Knight on October 26. Mr. Smedley is responsible for the scheme of the museum, which will embrace a purely local collection of Middlesex natural history and illustrations of ancient Tottenham, while the educational aspect will be kept well in view, including exhibitions of living animals and plants designed to encourage observation at first-hand in the field.

THE *Scottish Geographical Magazine* has received from Dr. J. P. Thomson some particulars of a great irrigation scheme which the New South Wales government proposes to carry out in the Murrumbidgee Valley and the Lachlan, Namoi, and Gwydor basins. The first work which it is proposed to undertake is the construction of a dam and reservoir at Barren Jack. Barren Jack is about thirty miles from Bowning Railway Station on the Sydney to Melbourne line. The site is a deep gorge, where the river has cut through a solid ridge of granite. The sides of the gorge are between 300 feet and 400 feet high. The proposal embraces constructing a wall 200 feet in height right across the Murrumbidgee, thus damming the waters back for a distance of 40 miles. The reservoir will contain one and a half time more water than Sydney Harbor, and, in fact, will be little inferior to the great Nile dam. Much of the area of the actual dam site is now under cultivation as agricultural farms, and these will all have to be resumed. The full capacity of the reservoir will be 33,380,864,000 cubic feet, and the cost of the dam, including resumption of lands, is £758,000. The dam will first be built to a height of 120 feet, and its full height will be reached, it is anticipated, in seven years from the date of its commencement. The catchment area is 5,000 square miles, embracing the whole of the country drained by the headwaters of the Murrumbidgee. One great feature of this scheme is that the waters will be brought to the land irrigated entirely by gravitation, and pumping will not be necessary. The new dam when constructed will be one of the greatest sights in the commonwealth, and the New South Wales government have selected a proposed site for the Federal capital right in its immediate neighborhood. This site is known as Makoolma. Two or three alternative lines for a light railway have been surveyed to connect Bowning with the dam.

THE total value of the stone produced in the United States during 1905, according to a forthcoming report of the United States Geological Survey, was $63,798,748. This total includes granite at $17,563,139, trap rock at $3,074,554, sandstone, not including grind-

stones and whetstones, at $8,075,149, bluestone at $1,931,625, marble at $7,129,071, and limestone at $26,025,210. As the corresponding value for 1904 was $58,765,715, it appears that the production showed a gain of $5,033,033 during 1905. The increased output for 1905 was caused by more activity in the building trades, and chiefly by a large increase in the output of limestone for use as furnace flux, which the reopening of many iron furnaces demanded. Granite, marble and limestone increased in value of output, while sandstone decreased slightly. Limestone showed the largest increase, from $22,178,964 in 1904 to $26,025,210 in 1905, or $3,846,246. Granite, including trap rock, gneiss, basalt, etc., increased in value from $20,015,025 in 1904 to $20,637,693 in 1905, a gain of $622,668. The trap rock increased in value from $2,823,546 in 1904 to $3,074,554 in 1905, or $251,008. Other granite increased in value from $17,191,479 in 1904 to $17,563,139 in 1905, a gain of $371,660. Marble increased in value from $6,297,835 in 1904 to $7,129,071 in 1905, a gain of $831,236. Sandstone, including bluestone, decreased in value from $10,273,891 in 1904 to $10,006,774 in 1905, a loss of $267,117. Bluestone increased in value from $1,791,729 in 1904 to $1,931,625 in 1905, a gain of $139,896. The sandstone figures showed a decrease in value of $407,013—from $8,482,162 in 1904 to $8,075,149 in 1905. The production of these different kinds of stone by individual states is set forth in detail in this report, which was prepared by Miss A. T. Coons, under the direction of Mr. Edwin C. Eckel.

UNIVERSITY AND EDUCATIONAL NEWS.

The General Education Board held a meeting last week when Acting-president Henry Pratt Judson, of the University of Chicago; President E. A. Alderman, of the University of Virginia, and President H. B. Frisell, of the Hampton Institute, were elected trustees. The following grants were made:

Drury College, Springfield, Mo.	$ 50,000
Iowa College, Grinnell, Iowa	100,000
Richmond College, Richmond, Va.	150,000
Lawrence University, Appleton, Wis.	50,000
Washington and Lee University, Lexington, Va.	5,000
Mercer University, Macon, Ga.	75,000
Randolph-Macon College, Ashland, Va.	100,000

The gifts made within the last six months, in addition to those already mentioned, are:

Tulane University, New Orleans	$75,000
Washburn College, Topeka, Kan.	25,000
Coe College, Cedar Rapids, Iowa	50,000
Wofford College, Spartansburg, S. C.	35,000
Furman University, Greenville, S. C.	25,000
Wake Forest College, Wake Forest, S. C.	37,500
Howard College, Birmingham, Ala.	25,000
Mississippi College, Clinton, Mass.	25,000
Southwestern University, Jackson, Tenn.	25,000

We understand that the institutions are required to raise three times the amount of the appropriation from the board.

The daily papers state that Mr. Andrew Carnegie has founded a scholarship in physics at the University of Paris with the sum of $2,500, in honor of the late Professor Curie and Mme. Curie.

Sir J. T. Brunner has endowed a chair of Egyptology in the University of Liverpool.

A new laboratory for experimental physics is in course of erection at the University of Toronto. The building is planned on the unit system and will cost when completed, with equipment, approximately $350,000. The laboratory is designed to accommodate the students in physics of the faculties of arts, medicine and applied science, which at the present time number about eight hundred.

The John C. Green School of Science at Princeton University has this year a larger enrollment than the academic department. The numbers in each class are: senior, 78; junior, 67; sophomore, 144; freshman, 183. The registration in the academic department is: senior, 207; junior, 181; sophomore, 167; freshman, 139.

Dr. H. E. Annett has been elected to a newly established chair of comparative pathology in the University of Liverpool.

Dr. Emil Philippi, docent in Berlin, has been elected to the Haeckel chair of geology and paleontology in the University of Jena.

Dr. Otto Jaeckel, curator in the Berlin Museum, has been called to a chair of geology at Greifswald.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 14, 1906.

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THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND THE NATIONAL SCIENTIFIC SOCIETIES.

THE scientific meetings to be held in New York City during convocation week, beginning on December 27, should be of more than usual interest and importance. This is the fifth of the convocation week meetings, the first having been held at Washington in 1902–3, followed by those at St. Louis, Philadelphia and New Orleans. The large meetings at Washington and at Philadelphia must be regarded as important steps in the organization of scientific men and of scientific work, and it is to be hoped that the New York meeting will be even more influential in unifying the diverse scientific interests of the country.

There are obvious objections to too great centralization, and there are doubtless many men of science who would prefer to see the different societies hold their separate meetings, but this has become almost impossible, if only because there are such close relationships between the sciences. For a while there was a tendency for the

societies to meet in two main groups, those devoted to the exact sciences holding their principal meetings with the American Association in the summer and those devoted to the natural sciences holding their principal meeting with the American Society of Naturalists in the winter. But it seems in many ways desirable that these two groups should not become separated, and in any case each group is so large as to interfere with the real advantages of compact and isolated meetings. Thus several years ago the president of Princeton University wrote that the university town could not accommodate the Naturalists and the affiliated societies. It has thus in any case become necessary to select a large city for the meetings, and when this is done it certainly seems desirable for the two principal groups of scientific men to meet together rather than apart.

The advantages and dangers of centralization as compared with local autonomy are similar to those which confront us in civil government. We must make as good a compromise as we can. The fundamental unit for scientific organization is obviously a group of men in the same neighborhood and interested in the same kind of work. The men of science in the same neighborhood should unite in so far as it serves their common interests into an academy for the city or state, and those pursuing the same science should unite in a national society. This organization has to a certain extent taken place. We have numerous local and state academies, often divided into sections or consisting of affiliated societies, and we have national societies for each of the sciences, often divided into local sections.

Probably many men of science regard an organization that would include these groups as too cumbersome to be workable, and it must be admitted that an annual plebiscite of all American men of science is out of the question. But the different sciences and the separate local groups have interests in common. It may be Utopian to fancy that scientific men will some day have control of the scientific interests of the country, but even under existing conditions they have real influence and serious responsibilities which require proper organization.

It is probable that the American Association will ultimately become an association of societies rather than of individuals, and that its work for the advancement and diffusion of science will in the main be performed by a house of delegates. We should perhaps consider the organization effected by the American Medical Association and the possibility of reorganizing the association to let it represent state academies, on the one hand, and national societies, on the other. It might be wise for the association to meet even now in three main sections: one for the eastern, one for the central and one for the western states, letting the council only migrate from one section to the other.

But whatever may happen in the future, it is just now the business of scientific men to make the approaching meeting as useful and profitable as possible, and each can accomplish the most by being present and taking part in the scientific sessions and social gatherings. This will require some sacrifice of convenience, especially for those living at a distance from the Atlantic seaboard. The holidays are short and the meetings follow closely on Christmas day. It is unfortunate that convocation week has not been completely established. It was hoped that our educational institutions and government offices would set aside the week in which New Year's day falls, or even the week following New Year's day, for scientific meetings. It should be recognized that attendance on these meetings is as important a part of the duties of scientific men as any in which

they are engaged. The committee of the American Association which had charge of the arrangements for convocation week secured assent to the plan from over sixty institutions, including all our larger universities, but in many cases the assent extended only so far as to give leave of absence to those who wished to attend the meetings. It is, of course, impossible for classes to be continued if all the officers of the institutions are absent, and it appeared to be necessary this year to hold the meeting in Christmas week, owing to the fact that New Year's day comes as early in the week as Tuesday. It is to be hoped that some joint effort can be made in cooperation with the societies devoted to history, economics, philology, art and other subjects that will ultimately establish a convocation week at some time in the year as part of the regular academic program.

It is to be feared that owing to the incidence of Sunday most of the program this year will be crowded into Thursday, Friday and Saturday, although some of the sessions will extend into the following week, and the meeting of the nominating committee of the association will be on Monday evening. The main features of the program, some of which have already been printed in SCIENCE, are as follows: The executive committee of the council of the American Association will meet at the Hotel Belmont on December 26 at noon and the register for the meeting will be open at two o'clock. On Wednesday evening there will be informal smokers and gatherings of members arriving in New York City at the Hotel Belmont and elsewhere. The council of the association will meet at nine o'clock on Thursday morning. At ten o'clock there will be a general session of the association and affiliated societies, when the retiring president, Dr. C. M. Woodward, will introduce the president of the meeting, Dr. W. H. Welch, and President Butler will welcome the members to Columbia University. The usual announcements will then be made. The sections of the association will hold at 11 o'clock their meetings for organization, followed in several cases by the address of the chairman. Most of the sections of the association and the national societies will meet at Columbia University on December 27 at 2 P.M. Several of the sections of the association will hold sessions in which topics of general interest will be discussed. At 8 o'clock the retiring president will give his address in Horace Mann Hall, his subject being 'Science and Education.' The addresses by the vice-presidents, in so far as the subjects have been announced, are: Professor C. F. Mabery, of the Case School of Applied Science, 'The Education of the Professional Chemist'; Professor Henry B. Ward, of the University of Nebraska, 'The Influence of Parasitism on the Host'; Professor Henry Crew, Northwestern University, 'Fact and Theory in Spectroscopy'; Dr. Erwin F. Smith, of the U. S. Department of Agriculture, 'Problems in Plant Pathology'; Professor Wm. T. Sedgwick, of the Massachusetts Institute of Technology, 'The Expansion of Physiology'; Dr. George Grant MacCurdy, of Yale University, 'Some Phases of Prehistoric Archeology.' Other vice-presidential addresses, the subjects of which are not yet announced, will be given by Dr. W. S. Eichelberger, of the U. S. Naval Observatory; Professor William North Rice, of Wesleyan University; Professor Irving Fisher, of Yale University, and by President F. W. McNair, of the School of Mines, Houghton, Mich.

The presidents of most of the national societies meeting at the same time will give addresses, many of which will be of general interest. The presidents of these societies are: The Astronomical and Astrophysical Society of America, Professor E. C. Pickering, of Harvard College Observa-

tory; the American Physical Society, Professor Carl Barus, Brown University; the American Mathematical Society, Professor W. F. Osgood, Harvard University; the American Chemical Society, Professor W. F. Hillebrand, U. S. Geological Survey; the Association of American Geographers, Mr. Cyrus C. Adams, New York City; the American Society of Zoologists, Professor W. E. Castle, Harvard University; the Association of Economic Entomologists, Mr. A. H. Kirkland, Malden, Mass.; the Society of American Bacteriologists, Dr. Erwin F. Smith, U. S. Department of Agriculture; the American Physiological Society; Professor W. H. Howell, the Johns Hopkins University; the Association of American Anatomists, Professor Franklin P. Mall, the Johns Hopkins University; the Botanical Society of America, Dr. F. S. Earle, Herradura, Cuba; the American Psychological Society, Professor James R. Angell, University of Chicago; the American Philosophical Association, Professor William James, Harvard University; the American Anthropological Association, Professor F. W. Putnam, Harvard University; the American Folk-lore Society, Professor A. L. Kroeber, University of California; the New York State Science Teachers' Association, Professor John F. Woodhull, Teachers College, Columbia University. In the case of the American Society of Naturalists the address will be given by Vice-president Davenport, on 'Cooperation in Science.' Owing to the lamented death of Professor Israel C. Russell, the president of the Geological Society of America, Professor W. M. Davis, of Harvard University, has become acting president, but it is understood that an address prepared by Professor Russell will be read. Among the numerous discussions may be mentioned one before the American Society of Naturalists on 'The Origin of Sex' and one before Section K on 'Protozoa as Factors in the Diseases of Animals and Plants.'

On Thursday evening the trustees of Columbia University offer a reception to the visiting societies and on Saturday evening the trustees of the American Museum of Natural History and the council of the New York Academy of Sciences offer a reception. There will be in connection with the latter a conversazione and an exhibit of scientific progress by the New York Academy. The academy has on several previous occasions arranged conversaziones of this character which have proved very successful. The scientific exhibit will also be open on Friday and on Saturday morning, while on Saturday evening there will be demonstrations and short addresses. Following the receptions at Columbia University and the American Museum of Natural History there will be smokers, the one at the Faculty Club and the other at the Chemists' Club. Friday evening is reserved for the dinners and the smokers of the special societies.

The City College has invited the members to luncheon and to an inspection of its beautiful new buildings on Saturday. At twelve o'clock, immediately preceding the luncheon, there will be addresses at the City College by Professor C. F. Chandler, of Columbia University, and by Professor John M. Clarke, of the Science Division of the New York State Education Department, the former speaking on the industries, the latter on the geology of Niagara Falls. On Saturday afternoon members are invited to the unveiling of ten marble busts of pioneers of American science, presented by Mr. Morris K. Jesup to the American Museum of Natural History.

While most of the meetings will be held at Columbia University, some of them will take place at the American Museum of Natural History, the New York Botanical Garden, the Rockefeller Institute and else-

where. It is almost impossible in the middle of the winter in a city like New York to arrange for general excursions, but there will be a number of excursions and visits arranged for various groups of scientific men.

The Hotel Belmont, Park Avenue and 42d St., opposite the Grand Central Station, has been selected as the headquarters of the association. Other hotels in the immediate vicinity are the Murray Hill, the Grand Union and the Manhattan. Hotels between the headquarters and Columbia University that can be recommended are the Empire, the St. Andrew and the Endicott. In view of the fact that there are many visitors in New York City at Christmas time, reservation of rooms should be made in advance.

The societies that will meet in New York City in convocation week and their officers are as follows:

American Association for the Advancement of Science.—December 27–January 1. Retiring president, Professor C. M. Woodward, Washington University, St. Louis, Mo.; president-elect, Professor W. H. Welch, The Johns Hopkins University, Baltimore, Md.; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Dr. John F. Hayford, U. S. Coast and Geodetic Survey, Washington, D. C.; secretary of the council, President F. W. McNair, Houghton, Mich.

Local Executive Committee.—J. J. Stevenson, chairman; C. C. Adams, Charles Baskerville, Franz Boas, N. L. Britton, H. C. Bumpus, Chas. A. Conant, Simon Flexner, Wm. J. Gies, Wm. Hallock, Alex. C. Humphreys, G. S. Huntington, Edward Kasner, Henry F. Osborn, C. L. Poor, Clifford Richardson, E. B. Wilson, Frederick J. E. Woodbridge, J. McKeen Cattell, secretary.

Section A, Mathematics and Astronomy.—Vice-president, Professor Edward Kasner, Columbia University; secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor W. C. Sabine, Harvard University; secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Mr. Clifford Richardson, New York City; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Mr. W. R. Warner, Cleveland, O.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Dr. A. C. Lane, Lansing, Mich.; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Professor E. G. Conklin, University of Pennsylvania; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president, Dr. D. T. MacDougal, Washington, D. C.; secretary, Professor F. E. Lloyd, Desert Botanical Laboratory, Tucson, Arizona.

Section H, Anthropology.—Vice-president, Professor Hugo Münsterberg, Harvard University; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Mr. Chas. A. Conant, New York City; secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Dr. Simon Flexner, The Rockefeller Institute for Medical Research; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

The American Society of Naturalists.—December 28. President, Professor William James, Harvard University; secretary, Professor W. E. Castle, Harvard University.

The Astronomical and Astrophysical Society of America.—December 27. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—President, Professor Carl Barus, Brown University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Mathematical Society.—December 28, 29. President, Professor W. F. Osgood, Harvard University; secretary, Professor F. N. Cole, Columbia University.

The American Chemical Society.—December 27–January 2. President, Professor W. F. Hillebrand, U. S. Geological Survey; secretary, Dr. William A. Noyes, the Bureau of Standards, Washington, D. C.

The Geological Society of America.—December

26–29. Acting president, Professor W. M. Davis, Harvard University; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

The Association of American Geographers.—December 31–January 1. President, Cyrus C. Adams, New York City; secretary, Albert P. Brigham, Colgate University.

The American Society of Zoologists.—December 27, 28, 29. President (Eastern Branch), Professor W. E. Castle, Harvard University; secretary, Professor H. S. Pratt, Haverford College. President (Central Branch), Professor C. C. Nutting, University of Iowa; secretary, Professor T. G. See, University of Michigan.

The Association of Economic Entomologists.—December 28, 29. President, A. H. Kirkland, Malden, Mass.; secretary, A. F. Burgess, Columbus, O.

The Society of American Bacteriologists.—President, Dr. E. F. Smith, U. S. Department of Agriculture; secretary, Professor S. C. Prescott, Massachusetts Institute of Technology.

The American Physiological Society.—December 27, 28, 29. President, Professor W. H. Howell, the Johns Hopkins University; secretary, Professor Lafayette B. Mendel, 18 Trumbull St., New Haven, Conn.

The Association of American Anatomists.—December 27, 28, 29. President, Professor Franklin P. Mall; secretary, Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

The Botanical Society of America.—December 27, 28, 29. President, Dr. F. S. Earle; secretary, Dr. William Trelease, Missouri Botanical Garden, St. Louis, Mo.

The American Psychological Association.—December 27–28. President, Professor James R. Angell, University of Chicago; secretary, Professor Wm. Harper Davis, Lehigh University.

The American Philosophical Association.—December 27–29. President, Professor William James, Harvard University; secretary, Professor John Grier Hibben, Princeton University.

The American Anthropological Association.—December 27–January 3. President, Professor F. W. Putnam, Harvard University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—December 27–January 3. President, Dr. A. L. Kroeber, University of California; secretary, W. W. Newell, Cambridge, Mass.

New York State Science Teachers Association.—December 26, 27. President, John F. Woodhull, Teachers College, Columbia University.

SCIENTIFIC BOOKS.

Early Chinese Writing. By FRANK H. CHALFANT. Memoirs of the Carnegie Museum, Vol. IV., No. 1.

The director of the Carnegie Museum, Dr. W. J. Holland, deserves the thanks of oriental scholars for his wisdom in inducing Mr. Chalfant to prepare this valuable and interesting memoir on early Chinese writing. Mr. Chalfant has been a missionary in China for nineteen years, and he certainly employed his time to good purpose in collecting data concerning the early forms of Chinese ideographs. His preliminary chapter on early writing derived from ancient inscriptions is an excellent discussion of the meaning of these primitive hieroglyphs, which began in the form of rude pictographs, and afterwards developed into what are commonly known as Chinese ideographs with their phonetics, radicals, etc. The author justly says that it was unfortunate that the word *radical* should have been applied to certain characters which usually, though not always, are associated with their meaning. He calls attention to a marked example of this incongruity in the group of symbols under the radical *corpse* very few of which have any relation to death.[1] Mr. Chalfant says that the radicals should more properly be called 'determinates' or 'classifiers.' The Chinese character used to express the idea means word-class or classifier, the colloquial term being word-mother, which after all conveys the meaning of radical or root. We may add that Dr. Edkins, the distinguished sinologue, in his 'Introduction to the Study of Chinese Characters' says the word radical is misleading. He says the equivalent *pu* means classes, and corresponds to our word kingdom in natural history, and orders in botany and zoology.

The student will find Mr. Chalfant's memoir of the greatest value in studying the evolution, so to speak, of the Chinese ideogram. At the

[1] In no better way can one appreciate the utter absence of scientific method in the Chinese than by a study of their ideographs. It is enough to say that European philologists alone have the ability to make clear the origin and classification of their symbols.

outset a character began as a rough outline of the object represented, and then by successive repetitions the outlines became more and more conventionalized until it reached its present form.[2] A suggestion of this evolution is given by Mr. Chalfant in twenty-nine plates with the characters arranged in horizontal lines, to the number of 403, each line presenting a number of variants, derived from ancient inscriptions. He gives first the modern character, its radical, the seal method of writing it in the early part of our era, and then several older forms with the suggestion of the original figure. The student will be greatly interested in the lucid discussions of these early forms which Mr. Chalfant illustrates so clearly. Edkins, in the book above mentioned, gives only one ancient form with each character, though in a supplement he gives many inscriptions from ancient Chinese bronzes.

Dr. John Chalmers published, in 1882, a book entitled 'The Structure of Chinese Characters Under 300 Primary Forms, after the Shwoh-wan, 100 A.D., and the Phonetic Shwoh-wan, 1833.' Here also only a single ancient form is associated with the modern character. This book, by the way, is the best one in English for the study of Chinese characters, for under each radical many important derivatives are given so that if one mastered all these he would have made a sound beginning in this fascinating study. Chalfant gives in twenty additional plates 439 of the Shuo Wen[3] radicals with their modern equivalents. In this memoir is also presented a fac-simile of the San Edict, filling nine pages with these ancient characters which date back to 1122 B.C., accompanied with a tentative translation. Mr. Chalfant says the text 'may be regarded as rightly belonging to the early date ascribed to it and I see no reason for suspecting it a forgery.' The writing was found inscribed on a bronze vessel, and the translation of it must have been a most difficult task. The inscription consists of a royal edict concerning the domain of San. "The instrument is executed in the form of an indenture with description of land and names of adjacent land-holders, as in modern Chinese deeds." The minute details show an advanced organization of society and might well belong to the Chow dynasty. We may add that a confirmation of the civilization of the Chinese at that early date may be gathered from W. R. Gingell's remarkable translation of a work known as the Institutes of the Chow Dynasty. Mr. Gingell entitles his translation 'The Ceremonial Usages of the Chinese, B.C. 1121 as Prescribed in the Institutes of the Chow Dynasty, Strung as Pearls.' No one can read this record without being impressed by the elaborate system of government, the complicated ceremonies attending every function, the minute rules observed in every employment and the overpowering forms of etiquette. Indeed, so extraordinary are many of these observances that one is inclined to believe them fabulous, the more so, as with such an advanced civilization as these records imply one wonders how a people could be content with a method of rude picture writing that would hardly do credit to an untutored savage. The mystery becomes the deeper when one considers that these people had on their western border an example of phonetic writing in the Sanskrit, and yet never abandoned their pictographic methods.

The evolution of these rude drawings into definite conventional characters is very instructive; as an example, a rude drawing of bushes which were formerly used for hedges to define the boundaries of a field, finally becomes developed into a character which means 'indicator.'

The interest attaching to Mr. Chalfant's memoir extends quite beyond the matter of Chinese characters and their origin. For those who still have a lingering idea that in the past there was some culture contact between the people of middle America and China it is natural to inquire if any resemblance can be found in the early writings of these two peoples, both of which wrote in picture symbols at the outset. This method of

[2] Of course there are thousands of characters which are made up of combinations of others acting as phonetics, or radicals, and these radicals in turn are often greatly abbreviated.

[3] Edkins gives this word Shwo wen, Chalmers gives it Shwoh-wan.

writing naturally depicted in many cases the same objects. Colonel Garrick Mallery, in his great volume on 'Picture Writing of the American Indian,' a publication of the Bureau of Ethnology, says: "The present collection shows the interesting psychologic fact that primitive, or, at least, very ancient man made the same figures in widely-separated regions, though it is not established that the same figures had a common significance." The rude pictographs of bow, sun, moon, eye and other objects may be found cut in rock throughout the world, but these coincidences do not indicate community of origin any more than do the rude stone arrow head and spear point which are world-wide in their distribution, and which Huxley said may be regarded as 'weapons of necessity.' Interesting coincidences do occur, as, for example, the Maya glyph for division is represented by an oblong oval figure with an inner oval outline having two vertical lines. This has been supposed to represent an obsidian knife. The Chinese ideogram for division represents a knife of another kind with two lines above representing a thing divided. The Egyptian glyph represents a knife like a chopper with a handle used in cutting leather, this also means division.

Mr. Chalfant gives a reproduction of rude characters found on fragments of tortoise shell and on bone arrow heads which were exhumed in the province of Honan in 1899. Many of these characters are rude pictures of objects, such as horse, stag, bird, scorpion, halberd, bow and arrow, wine-jar, hill, field and others. They are considered examples of the earliest writing of the Chinese. The profound difference between the Maya and associated glyphs of middle America, and the Chinese ideographs may be seen at a glance. Ranging over a period of 3,000 years, at least, the Chinese character has been in the form of lines either enclosing spaces as in sun, moon, field, etc., or lines running out from the figure like twigs from a tree. In the Maya and other glyphs of like character the lines of the drawing invariably enclose spaces. In other words the glyphs are made up of conventional drawings of skulls, feet, vessels, etc., in the solid. Here, indeed, one finds a fundamental difference in the two methods; the Maya glyph more nearly approaches the Egyptian hieroglyph in which the picture of the object is portrayed, though differing from the rude, conventionalized Maya in being drawn with remarkable fidelity and taste. The Maya glyphs have been derived from larger drawings, but in their condensed and abbreviated forms remind one of those shrunken and diminutive black human heads from South America, which though greatly reduced in size, still preserve the characteristics of the full-sized head. The Maya glyphs were evolved from more complex pictures, yet let one try to imagine a slow evolution of these glyphs at all paralleling the progressive development of Chinese characters and he is forced to admit their entire difference. As an example, take the modern Chinese character for turtle, and one can detect the back, the fore and hind legs, tail, etc.; the Maya glyph for turtle, on the contrary, represents the head alone with a few rudimentary designs below or at the sides, but unmistakable in its character with its recurved beak and peculiar turtle snout.

This brief review does scant justice to Mr. Chalfant's memoir, but we trust that his contributions may inspire others to enter this interesting field of research.

Edward S. Morse.

Forest Mensuration. By Henry Solon Graves. New York, John Wiley and Sons. 1906. Pp. 458. 8vo.

That forestry is a business—the business of making a revenue from wood crops—is now perhaps grasped by even the most recent novice in the ranks of propagandists for forest preservation. Every business requires the measuring of financial effects; inquiries as to the profitableness of its operations—the statics of expenditure and return—occupy the manager of every business. So in forestry, the recurring inquiry is: Will it pay? Will the effort and expense of making a plantation or of leaving parts of a forest uncut to secure a natural regeneration find eventually its proper reward?

How complicated and difficult the answer to this question must be can be realized when

one contemplates the long time which is involved, the many changes to which the crop is subjected during that time, varying its rate of growth from period to period, and its character, which the forester must be able to foresee. Finally, where finances are involved, market conditions must also be predicted: the forester must be a seer!

As in the factory, cost of output and sale value of product are compared, so in forestry the cost of producing wood and its eventual sale value need to be placed in relation. But, before a financial calculation can be made, we must be able to measure the product itself, and the methods that are employed to measure the volume of trees or parts of trees, of stands, forests, and of their increments from period to period are comprised under the name of forest mensuration.

It was quite natural that the first American professional text-book of forestry, worthy of the name, should occupy itself with this branch of the subject, which is to a large degree basic of all other branches. Dealing mainly with mathematical questions, it was possible to bodily transfer the European knowledge and practise, ready for our use.

The art of forest mensuration, as all other branches of forestry, has naturally been mainly developed in Germany, and as regards methods of procedure in the measurement, especially of standing timber and of increment, the author could add litttle to the contents of the latest German text-books. But in the matter of measuring felled timber, especially logs, the American method of employing the board-foot or some similar standard gave opportunity to add the matter contained in chapters II. to V. on log rules and scaling of logs, which would naturally not be found in European literature, the necessity for which we consider, however, a national misfortune.

It is unfortunate that we are doomed to remain in the backwoods as regards our units of measurement. If it is a pity that we have not yet adopted the metric system, it is almost a sin that we persist in continuing the use of the absurd log scales, and we regret that Professor Graves has not used the opportunity of inveighing more severely against this incubus.

There are not less than forty-five standards or units of measurement for logs employed in the United States, all varying in the board-foot contents they give for logs of the same cubical contents. It is a matter of experience that the results at the mill invariably belie the log scale. Professor Graves has treated this subject most fully and with an elaboration worthy of a better cause, admitting at the same time that 'the cubic foot will unquestionably be used more and more, as the value of timber increases and eventually replace the present rough unit, the board-foot.'

The other parts of the book are treated with similar clearness and elaboration, and the whole must be recognized as much a standard work—the first in the English language on the subject—as any of the best German text-books. Indeed, this book is in some respects an improvement by the addition of results of measurements in tables, which are usually not given in such text-books. The methods of estimating standing timber are also more elaborated than in European literature.

We welcome this contribution to professional forestry literature as distinctly an advance to our forestry movement.

B. E. FERNOW.

THE NUMBER OF KNOWN FERNS.

FEW persons not familiar with fern literature can begin to appreciate the scattered nature of the information that must be gleaned and sifted in the systematic study of the ferns of any region outside of temperate North America and Europe. The last summary of the ferns of the world was published a generation ago (1874) and proved a most useful work, notwithstanding two facts: (1) that its conservative authors, throwing geographic distribution to the winds, often included from two to twenty species under the single name of one of their so-called species of general distribution; and (2) that the use of the Kew method of citation for the author of the species made it practically impossible to trace a given species to its original descrip-

tion and so to its type-locality. 'Synopsis Filicum' served a useful purpose in its day, but the days of indiscriminate 'lumping' of species are over, and the really serious-minded who wish to attain accuracy in the scientific delimitation of species must have, even for the species known before 1874, a more accurate and available guide than this work. Besides this, the species that have been described in the last thirty-two years nearly equal those described before 1874.

It is, therefore, with the greatest delight that fern students of all lands will hail the completion of a publication whose earlier parts, already reviewed in this journal, have proved only a fair sample of what is, without question, the most useful single work on ferns that has ever been published.

'Index Filicum,' by Carl Christensen, now completed in a volume of eight hundred octavo pages is the work in question.[1] In this work each described species is entered not only under its original genus, but also under every successive generic name to which it has been referred in a century and a half of genus making, unmaking and remaking. For example the common male-fern of Europe is cited as *Polypodium filix-mas*, under which Linnæus first described it, and successively as *Dryopteris filix-mas*, *Polystichum filix-mas*, *Aspidium filix-mas*, *Nephrodium filix-mas* and *Lastrea filix-mas*, under which names it has successively appeared commencing with Adanson (1763), and under each of which it is known to-day in some part or other of Europe. Each reference gives a full citation with date, following almost exactly the American system for citation, and each entry has a cross reference to the generic name adopted in the work. Under the accepted one in the above case, *Dryopteris filix-mas*, the principal synonymy is given, together with the geographic distribution of the species. Genera and species are both included in one alphabetical series and selected forms of type readily distinguish accepted genera and species from synonyms, and these in turn from names of horticultural origin. Following this alphabetical index is a bibliography containing titles of all the works and papers in which genera and species of ferns have been defined, arranged alphabetically by authors, followed in turn by a systematic index of the bibliography by means of which one can quickly ascertain the extent of the literature bearing directly on the ferns of any continent, country or island, or on any genus or family of ferns.

The summary of entries includes 819 generic names and 22,680 specific names, which shows (1) the magnitude of the work, since these names are all entered at least twice, and (2) the extent of the synonymy, since the number of accepted genera is 149 and the number of accepted species is 5,940. To show the growth of our knowledge during a generation, we give in the following table a list of a few of the genera whose limits are alike in all the works cited, with the number of species in each as recognized in 1874 in *Synopsis Filicum*, as estimated by Diels and others in *Die natürlichen Pflanzenfamilien* in 1898, and as actually listed by Christensen in *Index Filicum* to the end of 1905.

Genus.	Species Recognized in Synopsis Filicum in 1874.	Species Estimated in Die Natürlichen Pflanzenfamilien, 1898.	Species Listed by Christensen, 1906.
Trichomanes,	91	80	228
Hymenophyllum,	80	74	231
Cyathea,	80	100 +	182
Hemitelia,	30	44	59
Alsophila,	90	112	185
Woodsia,	14	15	25
Cystopteris,	5	5	13
Adiantum,	80	80	184
Vittaria,	13	10–20	46
Gleichenia,	27	25	79
Marattia,	8	12	28
Ophioglossum,	10	30	43
Botrychium,	6	16	34

In sixty preliminary pages issued with the last part (12) of the work, Christensen gives a concise systematic enumeration of the gen-

[1] *Carl Christensen:* Index Filicum; sive enumeratio omnium generum specierumque Filicum et Hydropteridum ab anno 1753 ad finem anni 1905 descriptorum; adjectis synonymis principalibus, area geographica, etc. 8vo, pp. lx, 744. Hafniae, 1905–1906, apud H. Hagerup.

era adopted in the index, with synonyms and sectional divisions. This follows in the main the treatment in *Die natürlichen Pflanzenfamilien*, departing from it where recent monographic work seems to render it necessary, and changing generic names where priority requires. In this connection, it will be a rude shock to some of our conservative fern students to see the names *Dryopteris, Dennstædtia, Phanerophlebia, Phyllitis, Pteridium, Matteuccia, Cyclophorus* and *Ceropteris* accepted in place of names long cherished, but progress is inevitable and these names will stand because they are *right*.

To those people who still name ferns as new which are 'not described in *Synopsis Filicum*,' to whom it makes no difference whether the type locality of the name given to a West Indian fern is New Zealand, Mauritius or Jamaica, or to whom the mere priority of publication is of no concern, Mr. Christensen's book will be only a thorn in the flesh. To those whose ambition is to place fern delimitation and our knowledge of fern distribution on a stable and scientific foundation for accurate study, his work will be worth its weight in gold as a time saver, and a datum line for departure into new fields. Conceived in the same spirit as *Index Kewensis* for flowering plants, Mr. Christensen's work will far outrank it in accuracy, completeness and rational point of view.

The novice might well ask: Are the ferns all described in these 5,940 accepted species? Unhesitatingly we would say, No! Not all these names will stand, for there has been much avoidable and some unavoidable redescription in the absence of such an index as we now have before us. On the other hand, countries supposed to have been exhaustively studied are yielding frequent novelties. A single capital illustration is fresh from the antipodes. The island of Java has been classic ground for fern study since the time of Blume (1828). Raciborski has recently (1898) given us a fresh manual of the ferns of the vicinity of Buitenzorg. This last work includes only a single terrestrial *Ophioglossum*. An American morphologist visits Buitenzorg specially in quest of material bearing on this primitive type and what does he find? No less than four well-marked terrestrial species of *Ophioglossum* snatched from under the eyes of the slower European botanists who have exploited rather than exhausted the fern flora of the old world.

LUCIEN M. UNDERWOOD.
COLUMBIA UNIVERSITY,
November 10, 1906.

SCIENTIFIC JOURNALS AND ARTICLES.

The Botanical Gazette for November contains the following papers: 'The Ovule and Female Gametophyte of Dioon,' by C. J. Chamberlain. This genus is endemic in Mexico and it is probable that plants often reach the age of more than 1,000 years. The structures studied were the ovulate strobilus, the megasporophyll, the integument, the vascular system of the ovule, the megaspore membrane, the archegonium and the egg, the general conclusions being reached that Dioon resembles Cycas more than does any other living genus. 'Temperature and Toxic Action,' by Charles Brooks, the purpose of the experiments recorded being to determine what might be the modifying effect of temperature on the toxic properties of certain chemicals as shown by the effect of these substances on germination and growth in certain fungi. 'The Embryogeny of some Cuban Nymphæaceæ,' by Mel. T. Cook, giving an account of the development of the embryo sac, the endosperm and the embryo.

SOCIETIES AND ACADEMIES.

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE.

THE eighteenth meeting of the Society for Experimental Biology and Medicine was held at the Cornell Medical School, in New York City, on Wednesday evening, October 17. The president, Simon Flexner, was in the chair.

Members present.—Atkinson, Auer, Beebe, Buxton, Crile,[1] Dunham, Elser, Emerson, Ewing, Field, Flexner, Flournoy, Foster, Gibson, Gies, Hatcher, Lee, Levene, Levin, Loeb (L.),[1] Lusk, Mandel (A. R.), Meltzer, Meyer,

[1] Non-resident.

Murlin, Norris, Park, Richards, Salant, Schwyzer, Shaffer, Torrey, Wallace, Wolf, Wood, Yerkes.[1]

Abstracts of Original Communications.[2]

The Formation of Glycogen from Sugars by Muscle, with a demonstration of a perfusion apparatus: R. A. Hatcher and C. G. L. Wolf.

Contrary to the findings of Külz, saccharose does not yield glycogen in muscle. Glucose is a direct glycogen-former in muscle. No glycogen is formed from either glucose or saccharose in the glycogen-free muscles of animals which have been starved and treated with strychnin.

A perfusion apparatus was shown which permits the simultaneous and separate perfusion of the hind limbs of an animal and the arterialization of the blood by the lungs of two animals, each pair of lungs being used for an individual limb.

Bile Media in Typhoid Diagnosis: B. H. Buxton.

In the author's work 10 c.c. of blood, drawn directly from a vein, were distributed into three flasks containing 20 c.c. each of sterilized ox bile. This medium was used with great success in typhoid diagnosis.

The Inconstant Action of Muscles: Warren P. Lombard and F. M. Abbott.

The movements of the hind leg of the frog, which are generally ascribed to finely adjusted nervous coordination, are in fact largely the result of the mechanical conditions under which the muscles act. These conditions differ with each new position of the bones entering into the joints of the limb, and consequently alter the effect of the contraction of the muscles as the positions of the bones change during the course of any given movement. Thus a muscle which in one position of a bone acts as a flexor, in another position acts as an extensor, and a muscle which in one position of a bone may carry it dorsally, in another position may carry it ventrally. Manifestly it is absurd to try to class muscles as flexors and extensors, for example, or to try to name them according to the movements which they are supposed to produce. A study of central coordination must be postponed until the effects of peripheral coordination based on joint and muscle mechanics has been ascertained.

The Senses and Intelligence of the Chinese Dancing Mouse: Robert M. Yerkes.

For a few days during the first month of post-natal life dancing mice respond definitely to sounds, but neither direct nor indirect methods of testing auditory sensitiveness furnish any evidence of it in the adult. Brightness vision is fairly acute; color vision is poorly developed. In visual discrimination the mice apparently depend upon brightness differences. The behavior of the dancing mouse is readily modifiable. Modifications of behavior occur more rapidly in the male than in the female. Individual differences in plasticity and in the permanency of modification are marked. There is little evidence of any form of imitative tendency in behavior.

On the Motor Activities of the Alimentary Canal after Splanchnic and Vagus Section. W. B. Cannon. (Presented by S. J. Meltzer.)

Movements of the Esophagus.—Splanchnic section resulted in no deviation from the normal. Bilateral vagus section resulted in the well-known paralysis of the thoracic esophagus. A distinction must be drawn between the immediate paralyzing effect on the esophagus of cutting the vagi, and the later partial or almost complete recovery of efficiency by a local mechanism in the esophageal wall.

Movements of the Stomach.—Splanchnic section caused no alteration from the normal movements. The immediate effect of vagus section was tardiness in the starting of gastric peristalsis after food was introduced into the stomach. Again a distinction must be drawn between the first and the later effects of vagus section.

[2] The abstracts presented in this account of the proceedings have been greatly condensed from abstracts prepared by the authors themselves. The latter abstracts of the communications may be found in number one of volume four of the society's proceedings.

When all the extrinsic nerves were cut the gastric waves passed at the usual rhythm, but were unlike those seen when the vagi alone were cut in being, from the first, deep and powerful contractions. After death in these cases the stomach was usually found to be strongly contracted.

Passage of Carbohydrate and Protein Food from the Stomach.—After total suppression of impulses through the splanchnics both carbohydrate and protein foods are discharged through the pylorus at practically the normal rate. In the absence of impulses through the vagi and in the presence of impulses through the splanchnics the discharge of both carbohydrate and protein is notably retarded. But this retardation, especially when protein is fed, is much more marked soon after the operation than it is later. Again a distinction must be drawn between the immediate depressing effect of vagus section and the later considerable recovery of normal functioning.

When all extrinsic nerves have been cut, there is, as in the cases of vagus section alone, a difference between the immediate defect and the later partial recovery of normal function.

Passage of Food through the Small Intestine.—After splanchnic section the rate of transit from pylorus to ileocolic sphincter, when protein was fed, was much accelerated, and after vagus section it was much slower than normal. The rate was slower also when all nerves were cut. The variation from the normal was in all cases less with carbohydrate food than with protein.

Rhythmic segmentation of the food in the small intestine was observed in every condition of nerve section.

The persistence of characteristically different rates of discharge of protein and of carbohydrate food through the pylorus, after splanchnic section, after vagus section, and after severing both sets of nerves in the same animal, definitely proves that the control of this differential discharge is local and not mediated through the central nervous system.

Experimental and Clinical Observations upon Direct Transfusion of Blood: G. W. CRILE.

By means of end to end anastomosis by suture, blood was transfused in 74 dogs. Blood was transfused, retransfused and reversely transfused over a period of a month in the same dogs. There were no agglutins or hemolysins produced, no hemoglobinuria and no nephritis. Blood was found physiologically interchangeable. Every degree of hemorrhage, even to cessation of the arterial stream, was successfully treated.

In six clinical cases of hemorrhage treated by transfusion of blood the results were the same as in the laboratory. The hemorrhage factor was eliminated.

On the Normal Peristaltic Movements of the Ureter: D. R. LUCAS (by invitation).

In dogs narcotized with morphin the peristaltic *contractions* of the middle part of the ureter occur at intervals varying between 6 and 15 seconds. The curves representing these contractions were of variable but generally of fairly good size. These peristaltic contractions are apparently the same as those which Engelmann and other writers observed. The author found, however, *that the renal pelvis as well as the uppermost part of the ureter exhibits peristaltic contractions of another kind;* they are small, of short duration and occur every three or two seconds.

In some animals, in which the contractions from the middle part of the ureter presented fairly large curves, it frequently happened that these curves were superimposed by finer undulations. From the lower end of the ureter only a few tracings were obtained. It seems that in the lower end, also, the small and more frequent contractions predominate.

Anesthetics, *e. g.*, chloroform or ether, exercise pronounced inhibitory effects on ureteral peristalsis. The relatively slight and more frequent contractions appear to be less affected than the others by anesthetics.

Gastric Peristalsis under Normal and Certain Experimental Conditions: JOHN AUER.

The author has devised a very simple and satisfactory means of studying gastric peristalsis. He finds that if a well-fed rabbit is stretched out on its back and the hair of the epigastrium clipped, any observer may see

active gastric peristalsis under a closer approximation to physiological conditions than the saline bath affords. Mere inspection of the abdomen of a rabbit in this position shows that the stomach is far from inert. A short time after preparing the animal, peristaltic waves are seen coursing over the stomach from left to right, increasing in strength as the pyloric third is approached. These waves are easily registered by placing a tambour over the stomach region to be studied and connecting it with a writing tambour or manometer. The writing tambour registers not only the change in volume of the stomach part it overlies, but also the respiration of the animal; in many cases, with delicate adjustment of the writing pen, the heart beats are also marked.

A study of gastric peristalsis by this method has shown that as a rule the stomach is motionless for awhile after the animal is placed upon its back and its limbs are extended, but that active peristalsis is reestablished a few minutes afterward. Cessation of gastric peristalsis is also caused by the operation of opening the abdominal cavity, by section of both vagi in the neck and by subcutaneous injection of morphin. Inhibitory effects are also caused by ordinary inhalation of ether and by fasting. Intravenous injection of curare does not abolish gastric peristalsis so long as artificial respiration is maintained. Feeding reestablishes peristalsis after its discontinuance from fasting.

Reflex Inhibition of the Cardia in Rabbits by Stimulation of the Central End of the Vagus: S. J. Meltzer and John Auer.

At the last meeting the authors reported that by stimulation of the central end of the vagus a tetanic contraction of the entire esophagus can be produced in dogs and cats, but not in rabbits. In continuation of their studies the authors have found that *stimulation of the central end of the vagus causes a distinct inhibition of the cardia in rabbits.* The cardia of the rabbit is normally contracted in a moderate degree. Furthermore, at each deglutition the peristaltic movements of the esophagus terminate in a characteristic contraction of the cardia—it sinks into the stomach. Finally, after a stimulation of the peripheral end of the vagus the cardia contracts in the same characteristic way. The authors found that these three states of contraction can be definitely inhibited by a stimulation of the central end of the vagus. In the first place the cardia relaxes—bulges up during such stimulation. In the second place, if deglutition occurs, the cardia fails to contract so long as the central end of the vagus is being stimulated. Finally, the interruption of the stimulation of the *peripheral* end of the vagus does not bring on a contraction of the cardia while the central end is being stimulated.

Continuous Anesthesia by Subcutaneous Injection of Magnesium Sulfate in Nephrectomized Animals: D. R. Lucas and S. J. Meltzer.

Nephrectomy prevents rapid excretion of magnesium sulfate after its subcutaneous introduction. Consequently half the dose of this salt that is required per kilo to anesthetize a normal rabbit suffices for a nephrectomized rabbit. Furthermore, the anesthesia caused in nephrectomized rabbits by half the usual dose is deeper and lasts longer, because most of the magnesium compound is unable to leave the body. The anesthetic results with magnesium sulfate, in normal and nephrectomized rabbits, are in sharp contrast to the toxic effects of strychnin under analogous circumstances.

Remarks on and Exhibition of Specimens of a Metastasising Sarcoma of the Rat: Simon Flexner and J. W. Jobling.

The exhibited specimens consisted of a mixed-cell sarcoma, of the seminal vesicle of a white rat, which had been transplanted successfully into a series of white rats. The original tumor, which was found in a rat dying spontaneously in the laboratory, was as large as a walnut. Its surface was covered with peritoneum and its consistence was firm. Thus far it has been transplanted to full-grown and young rats both by subcutaneous and by intraperitoneal inoculation. The features of the tumor which the authors especially emphasized were the large and numerous

metastases which have appeared in the inoculated rats. The rat containing the original tumor did not show visible metastases. But in the animals which have succumbed after successful inoculation, the metastases have been numerous and of large size. They have appeared in the lungs and kidneys, and in one instance, following intraperitoneal injection, in the ribs and intercostal muscles. As the specimens showed, the nodules in the lungs and kidneys reached large dimensions, taking in a segment of a kidney or an entire lobe of the lung. The animal in which metastases existed in the intercostal muscles showed large nodules in the lung; in this animal a growth from the lung into the pericardium, and from the pericardium into the heart wall, took place. The secondary tumors had the same structure as the primary tumors. They were made up of spindle-shaped and polygonal cells; the latter were often of large size, with lobed or regular nuclei. Intercellular substance was present, and in places was fibrillated.

The epicardium in the rat, in which growth occurred in the myocardium, showed invasion of the serosa by the sarcomatous cells, having spread doubtless from the nodule mentioned and caused sarcomatosis of the serous membrane. This tumor is being further transplanted and studied in its biological relationships.

The Influence of Water on Gastric Secretion and the Combining Affinity of Mucus for HCl in the Stomach: N. B. FOSTER and A. V. S. LAMBERT.

Pawlow called attention to water as a stimulant of gastric secretion, but the degrees and limitations of stimulation produced by water in food Pawlow has not recorded. Using dogs with Pawlow fistulas, it was observed that with definite amounts of cracker meal as food the amount and rate of gastric secretion depend to some extent on the amount of water given the dog with his meal, *i. e.*, when small amounts of water are given, the secretion is slow and scanty. If larger quantities of water are mixed in the food the secretion is more abundant.

The degree of acidity of gastric juice depends upon the amount of secretion. When this is considerable it is much more acid than when the secretion is scanty. Pawlow is of the opinion that the degree of acidity of the gastric juice is constant; this can hardly be correct, however, for the total acidity changes from hour to hour. Pawlow evidently determined free HCl only, but the amount of free acid is dependent on the amount of mucus secreted, since mucus like other protein products combines with HCl. Mucus in the presence of pepsin combines with HCl to a very considerable extent and undergoes digestion with formation of proteoses.

The Action of the Electric Current on Toxin and Antitoxin: CYRUS W. FIELD and OSCAR TEAGUE.

The authors alluded to the unsuccessful attempts of various observers to ascertain definitely the nature of the electric charges carried by particles of toxins or antitoxins. Believing that such failures were due to the disturbing influences of products of electrolysis, the authors successfully eliminated the latter in their experiments. They found that both toxin and antitoxin particles travel toward the cathode and must therefore carry positive charges. This holds true when the tested fluid is made either acid or alkaline in reaction.

Since a true chemical reaction can take place only between ions carrying charges of opposite sign, the fact that toxin and antitoxin are both electro-positive would indicate that the combination of these two substances represents not a chemical union, but rather the adsorption of one colloid by another.

Nuclein Metabolism in a Dog with an Eck Fistula: J. E. SWEET and P. A. LEVENE.

A dog with an Eck fistula was maintained in nitrogenous equilibrium on a diet consisting of cracker meal, plasmon and lard. In this dog the output of uric acid was greater than from the normal animal. During fasting, after administration of nuclein, nucleic acid or of adenin, and during a period of feeding with a diet containing a small proportion of protein but of high caloric value, the excretion of uric acid was also increased. Ingested

thymin was recovered in large proportion from the urine. It was impossible to detect thymin in the urine after feeding nuclein or nucleic acid.

On the Fractioning of Agglutinins and Antitoxin: R. B. Gibson and K. R. Collins.

The results of the work thus far accomplished have demonstrated the untrustworthiness of a differentiation of the antibodies into those contained in euglobulin and those in pseudoglobulin, a finding in accord with the recent criticisms of salt fractionation by Haslam, and by Osborne and Harris.

No evidence has been found in these experiments to show that the agglutinins developed in rabbit, goat or horse serum can be either euglobulin or pseudoglobulin, or that these antibodies can be separated from one another by ammonium sulfate fractionation.

Further Observations of the Effects of Ions on the Activity of Enzymes: William N. Berg and William J. Gies.

The authors have found that the sequence of zymolysis in both velocity and extent in given groups of equivalent (percentage, molecular, normal, dissociated) acid or basic solutions varies considerably with the nature of the protein. This fact makes it impossible accurately to formulate statements regarding various phases of peptolysis or tryptolysis without specifying the particular protein involved in the process; it also renders doubtful various general conclusions of common acceptance pertaining to digestion that have been derived, in one research or another, from the use of a single protein. A study of the peptolysis of *many proteins* in a given series of acid solutions has therefore been undertaken, and an effort will be made to extend the observations to the tryptolysis of the same proteins in a similar series of basic solutions.

The speed and degree of both peptolysis and tryptolysis are resultants of conflicting influences. In the case of peptolysis, for example, the hydrogen ions in a given acid solution are always essential and positive factors, whereas, the accompanying anions or molecules (perhaps both) appear to be, *as a rule,* non-essential and inhibitory factors. That acid *molecules* are *not necessarily* inhibitory in peptolysis, however, was shown in a number of experiments with acetic acid, which neither favored nor interfered with peptic digestion materially when present in different amounts in solutions containing constant proportions of hydrochloric acid.

William J. Gies,
Secretary.

The Philosophical Society of Washington.

The 620th meeting was held on October 13, 1906, President Abbe in the chair.

The evening was devoted to the subject of earthquakes.

Mr. C. F. Marvin, of the Weather Bureau, said the present year has been noteworthy because already 58 shocks have been recorded, while there were only 23 in the previous three years. He exhibited the Washington record of the San Francisco shock, showing a duration of about four hours, for the horizontal motion, while near the seat of the disturbance the duration was only a few minutes. The general nature and peculiarities of such records and the formulæ based on them by Japanese seismologists were presented briefly.

Mr. F. B. Littell spoke on 'Spirit-level Disturbances at the Naval Observatory due to the Chilean Earthquake.' While observing with the alt-azimuth instrument, which has two levels in the north and south plane, sensitive to 0.1″ or 0.2″, he observed oscillations amounting to 2″ and having a period of 18 seconds; these were reduced to 1″ after five minutes and to ½″ after about twenty minutes. The time was 7:49.

A large number of lantern views taken in and near San Francisco by Mr. G. K. Gilbert were then exhibited and briefly explained by Mr. Nutting.

Informally Mr. Press spoke of some experiments made with large hailstones; some on cracking appeared to have a bubble of air, but when stones of similar appearance were dissolved in water no bubbles rose. The president stated that this was the general experience except for one observer who wrote many years ago.

The 621st meeting was held on October 27,

1906, Vice-president Hayford in the chair.

R. A. Harris presented a paper entitled 'Elementary Notions relating to Integrals in General Function Theory' which treated of integration around a pole of a function, and of Cauchy's theorem.

It was pointed out that any element Zdz, where $Z = 1/z - c$ and dz is an elementary arc of a small circle about c, is simply a vector in the y-direction, $2\pi/n$ in length, n denoting the number of parts into which the circumference is divided. Consequently,

$$\int Zdz = \frac{2\pi i}{n} \times n = 2\pi i.$$

This established, it readily follows that

$$\int Zdz = 2\pi i f(c) \text{ where } Z = \frac{f(z)}{z-c},$$

f having no zero in the neighborhood of c.

Cauchy's theorem was demonstrated for circular paths, for paths enclosing slender areas, and for any path.

In the first case the truth is obvious if Z denote a power-series. For, the argument of $Z_\nu dz$ varies $\nu + 1$ times as fast as does the argument of dz, and as dz takes all directions uniformly on account of the path being circular, so does $Z_\nu dz$. (ν refers to any particular term of the power-series.) The aggregate of the dz's being zero, so must be the aggregate of the $Z_\nu dz$'s or of the Zdz's.

For slender strips the theorem is obvious because the variation in the value of the function for an infinitesimal z-rectangle or square can be ignored in such products as Xdx, etc., if only ∞^1 of these rectangles go to make up the given strip.

Finally, by taking into account the variation of the function when z describes an infinitesimal square, so that instead of X, say, we have for the X-coordinates of the middles of the sides of the transformed square

$$X - \tfrac{1}{2}\frac{\partial X}{\partial y}dy, \quad X + \tfrac{1}{2}\frac{\partial X}{\partial x}dx, \text{ etc.}$$

With these values for X and similar ones for Y, the value of Zdz for the four sides of the elementary square is readily obtained. This sum will vanish, including infinitesimals of the second order, if the conditions for a monogenic function are satisfied. A given area comprises ∞^2 elementary squares, and so the neglected infinitesimals of the third order are of no consequence in the result.

Mr. A. Press presented 'Studies in Soil Capillarity.'

There seems to have been considerable misconception of what constitutes the capillary height of soils. A mere presence of moisture can not be an index of how much water will rise in a soil by virtue of capillary action. If one will drive home the analogy of capillary movement in fine bore tubes the 'capillary height' can be defined as that height to which moisture will rise in a soil where there is complete filling of the pore-space of the soil. This maximum height will be definite just in proportion as the soil-particles are homogeneous in size. However, if an equilibrium-condition is established in a soil, the indefiniteness of the capillary height is not so marked. This is proved by the experiments of Professor King when ten-foot cylinders of soil were employed, and after being first surcharged with moisture draining was continued for a period of about two years. Moisture above the capillary height can only be adsorption moisture and the pore-space need not necessarily be entirely filled. There are two types of adhesion-water: the one dry, the other wet; the first is hygroscopic water and is explained on Laplace's theory of molecular (surface) attraction; the second is of the same nature but differs in degree, because in the one the water-vapor has first to be condensed to water before strict adhesion can take place, and in the other no extra amount of energy is called for, because by wetting the soil (above the capillary height) the bonds of attraction of soil for moisture are more easily satisfied. Mulching, to be beneficial, depends upon whether the capillary height is exceeded or not. A so-called 'natural mulch' would be where the capillary height is below the surface of the soil.

Dr. Parks's experiments, in the *Philosophical Magazine*, show that the attraction of powders for moisture practically follows the law:

$$\frac{d\omega}{dt} = A(W - \omega),$$

where ω is the water content and W is the maximum moisture of (wet) adhesion, and where also A is a constant. If this law of attraction is used, we can determine the general equation of water-flow in one direction in soils by considering the attraction at two points removed by the distance dx of length, and taking into account the resistance of flow due to viscosity. The equation is, by employing the generalized Ohm's law,

$$\left(\frac{d\omega}{dt}\right)^2 + a^2\frac{d\omega}{dx} = 0.$$

If the boundary conditions can be satisfied the flow of moisture can be determined from one part of a soil to another with regard to time.

THE 622d meeting was held on November 10, 1906, Vice-president Bauer in the chair.

Mr. A. L. Day presented some results of investigations on 'Lime-Silica Mixtures' made at the Geophysical Laboratory. Considering first the materials separately: silica is melted with great difficulty and becomes very viscous; the first traces of melting appear about 1,600° C.; powdered quartz heated in the electric furnace and cooled shows traces of crystallization as tridymite about 1,000°; lime melts to a thin liquid in the arc and when recrystallized is very insoluble in water. Mixtures of the two were studied pyrometrically, chemically and microscopically. As the percentage of silica increased the melting point generally rose, the graph showing two maximum points, corresponding nearly to definite chemical combinations, separated by sharp minima not much lower in temperature.

Mr. J. F. Hayford gave an account of the 'Meeting at Budapest of the International Geodetic Association' in September, 1906. (See SCIENCE, December 7.)

CHARLES K. WEAD,
Secretary.

THE TORREY BOTANICAL CLUB.

The second stated fall meeting of the club was held at the museum building of the New York Botanical Garden on October 31, 1906, at 3:30 P.M. In the absence of the president, Professor H. M. Richards presided. Twenty-three persons were in attendance.

Dr. Britton presented the matter of the club's action in connection with the meeting of the American Association for the Advancement of Science, to be held in New York City, December 27–31. The program of meetings for the association week was read and motion was made that a committee of five, including the chairman of the meeting, be appointed by the chair, with power, to arrange for a reception to visiting botanists in Schermerhorn Hall, Columbia University, on the evening of December 26. The motion was carried. The personnel of the committee is as follows: Professor H. M. Richards, Professor L. M. Underwood, Dr. H. H. Rusby, Mrs. E. G. Britton, Dr. C. Stuart Gager.

The following papers were presented:

Remarks on the Formation of Aerial Tubers in Solanum tuberosum: Dr. C. STUART GAGER.

A brief outline was first given of the steps in the germination of the potato seed, up to and including the growth of the primary rhizomes, and the formation at their distal ends of the first tubers. Reference was then made to two recent publications in *Torreya* (6: 181 and 211, 1906), describing an anomalous formation of a tuber of *Solanum tuberosum*, on a sprout from a seed tuber, in daylight, and briefly summarizing the pertinent literature.

The specimen in question, with photograph, was then exhibited, and possible causes of the anomaly discussed. Prunet's researches (*Rev. gen. d. Bot.* 5: 49. 1893) led him to the conclusion that, at maturity, the apical and basal ends of the mature tuber are physiologically different, due to a redistribution, after the cessation of growth, of the reserve materials stored in the tuber while it was forming. The validity of this conclusion has never been tested by other investigators, and it was thought improbable that such a condition, even if it existed in the seed tuber which bore the anomaly, would enter as a causative factor.

The specimen exhibited, and numerous other recorded cases of the formation of tubers on aerial branches, render very improbable the

suggestion of Noël Bernard (*Rev. gen. d. Bot.* 14: 139, 269. 1902), and of Jumelle (*Rev. gen. d. Bot.* 17: 49. 1905), that potato tubers are caused by a fungus, a species of *Fusarium*, endotrophic with *S. tuberosum*.

In the normal formation of tubers two kinds of factors are doubtless involved: the first organic, consisting of specific peculiarities in the protoplasts; the second environmental, comprising external conditions, especially of light and moisture, and the stimulus of the various metabolic products within the stem. The ability to induce tuberization in aerial stems by depriving them of light and reducing their transpiration, as Vöchting did, and the sport described by Vilmorin (*Torreya, l. c.*), suggest that the specific cellular peculiarities obtain throughout the entire shoot system, and need only the stimulus of definite environmental conditions, either external or internal, to make them operative.

In this connection it would be desirable to know whether the presence, in any portion of the potato stem, of a superabundance of food materials would operate as a stimulus, causing the excessive formation of parenchymatous cells, which, gorged with the reserve food, make up the greater part of the bulk of the tubers. It is well known, through the researches of Knight and others, that, if the flow of food materials is diverted from incipient underground tubers by removing them as fast as they begin to form, this material will accumulate in portions of the aerial stem, causing tubers there. In the specimen in question, translocation of digested food became established toward and into the developing 'sprouts,' but elongation of the latter was not favored because of the very slight water-supply from without. It does not seem improbable that a combination of these two conditions alone would be sufficient to produce the tuber, even in daylight.

Two New Coralline Algæ from Culebra, Porto Rico: Dr. MARSHALL A. HOWE.

Dr. Howe exhibited and discussed briefly specimens representing two rather large and conspicuous kinds of non-articulated corallines which were secured during a visit made last March to the island of Culebra. These have been studied in collaboration with Dr. M. Foslie, of Trondhjem, Norway, and a joint paper, in which the two new species are to be described and illustrated, is soon to be published. One of the species is a *Goniolithon* which seems to have its closest affinity among the forms already described in a species originally found on the island of Funafuti, of the Ellice Islands group, in the South Pacific. The second species, a *Lithophyllum* which forms columnar flat-topped masses sometimes a foot in height, is evidently a reef-builder at Culebra, and, like the other, curiously enough, finds its nearest relative in a species originally described from Funafuti and since reported from the Maldives in the Indian Ocean. The speaker remarked upon some of the general characteristics of the non-articulated corallines, and showed microtome sections and photomicrographs illustrating the structure of the two species that were under discussion. In reply to a question as to the ecological relationships of the coralline algæ and the true corals, it was stated that though certain species of both groups are reef-builders and inhabit similar places, each of the groups seems to be somewhat inimical to the other. A place in which corals are flourishing is not a good place in which to look for coralline algæ, and *vice versa*. It is a common thing to find corallines attached to dead or moribund corals, but comparatively rare to find the corals growing on calcareous algæ. In one case a crustaceous coralline was noticed to be encroaching upon and covering a living coral.

Remarks on the Flora of Nova Scotia: Dr. C. B. ROBINSON.

The province of Nova Scotia consists of a peninsula connected with New Brunswick by an isthmus of very slight elevation, and the island of Cape Breton separated from the rest of the province by the Strait of Canso, which at the narrowest place is less than a mile broad. The northern part of the island is composed of hills between 800 and 1,400 feet high, except narrow strips along the coast and in the river valleys.

In general the flora of the peninsula and island is composed of plants which have mi-

grated from the west or southwest through New Brunswick, many species having their northeastern limit in the province. A second source lies in the introduction, chiefly from Europe, of weeds in ballast, etc., and many species thus added to the flora are very conspicuous and troublesome. But the main purpose of the paper was to call attention to the presence in northern Cape Breton of a third element, namely, species that are believed not to occur anywhere upon the peninsular portion of the province, and in some cases not in New Brunswick. Such cases are always open to the suspicion of incomplete collection, but this can hardly be held to explain the gap in the distribution of the male fern, *Dryopteris filix-mas* (L.) Schott., known from about twenty localities in this region, although nowhere abundant there, and not found otherwise east of Vermont. Another conspicuous fern reported from two rather widely separated districts in northern Cape Breton is the holly fern, *Polystichum Lonchitis* (L.) Roth., and no other stations are recorded east of Ontario. A similar statement may be made about many flowering plants, those referred to being *Carex abacta* Bailey, *Blephariglottis blephariglottis* (Willd.) Rydb., *Sanguisorba canadensis* L., *Aster nemoralis* Ait., not known from peninsular Nova Scotia, *Drosera intermedia* Hayne and *Solidago macrophylla* Pursh, only so far found there immediately east of the Strait of Canso.

It was attempted to correlate this with the observations of Canadian geologists to the effect that the region in question had escaped glaciation, the limit of the ice-sheet being not far from Pictou.

Specimens were also shown of several species not hitherto recorded from the province, among them *Tetragonanthus deflexus* (J. E. Smith) Kuntze, *Sparganium fluctuans* (Morong) Robinson, *Meibomia canadensis* (L.) Kuntze, *Vicia hirsuta* (L.) Koch, *Falcata comosa* (L.) Kuntze, *Chænorrhinum minus* (L.) Lange, and *Triglochin palustris* L.

Account of a Collecting Trip to the Sierra Maestra of Cuba: Mr. Norman Taylor.

Before giving an account of the various trips made during the expedition, a description was given of the Sevilla Estate, which is a local name for the area visited. This is a tract about forty miles long, having for its southern limit the Caribbean Sea. Its northern boundary is the ridge of the Sierra Maestra range. At its eastern and lower end this range is about 3,500 feet high, but rises in altitude, and gradually approaches the coast as it goes to the westward, reaching its culminating point near El Turquino, a mountain credited with an elevation of 8,400 feet. There is no gradual descent from the ridge of the Maestra to the sea, but numerous other mountains intervene. This feature, together with the river valleys, makes the country very rugged and precipitous.

The chief rivers, the Sevilla, Guama, Bayamita and Peladeros, rise in the Maestra itself, while numerous others of uncertain local names rise in the front ranges. All the rivers, at this time of the year, flow under the ground for the last two miles, so that it is easily possible to get across near the coast, but in the rainy season they flow in the surface bed and are quite impassable.

The prevailing wind is the moisture-laden northeast trade. On this account the rainfall is abundant on the windward side of the Maestra while the leeward side of the range is dry and arid. The increasing altitude of the mountains from east to west and the decrease in the width of the strip of land lying between them and the sea make the effect of this great wind-shield still more marked as one travels westward. Here at least two species of *Cereus*, and an *Agave*, together with many other sub-xerophytic plants, were found.

Among the interesting plants collected were specimens of *Pinus occidentalis*. This pine occurred on the mountains at elevations between 1,000 and 2,300 feet, and was plentiful in many places. The great size and inaccessibility of the trees of *Ceiba pentandra* that were found in the mountains was cited as a factor that must have some bearing on the probable new world origin of the species.

Discussion followed by Dr. Britton and Dr. Howe, the former giving recent evidence collected by him in Jamaica, pointing toward the

conclusion that the *Ceiba* may very probably be considered as a native of the new world.

C. STUART GAGER,
Secretary.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY OF THE UNIVERSITY OF NORTH CAROLINA.

THE 168th meeting of the society was held in the main lecture hall of the new chemical laboratory on Tuesday evening, November 20, at 7:30 P.M., with the following program:

PROFESSOR A. S. WHEELER: 'Denatured Alcohol.'

PROFESSOR J. E. MILLS: 'The Mutual Absorption of Attraction by the Attracting Particles.'

A. S. WHEELER,
Recording Secretary.

THE ST. LOUIS CHEMICAL SOCIETY.

AT the meeting of the St. Louis Chemical Society on November 12, Dr. H. M. Whelpley presented a paper, entitled 'The United States Pharmacopœia and National Formulary, the Standard Authority of the Food and Drugs Act of June 30, 1906.' The paper was due to the interest in the pharmacopœia developed by the new law. The speaker gave a brief history of pharmacopœias in general and of the United States Pharmacopœia in particular, dwelling especially on the methods pursued by the Pharmacopœial Convention, in the decennial revisions of the national standard.

C. J. BORGMEYER,
Corresponding Secretary.

DISCUSSION AND CORRESPONDENCE.

THE 'ELIMINATION' AND 'FIRST SPECIES' METHODS OF FIXING THE TYPES OF GENERA.

IN a recent number of SCIENCE Mr. Witmer Stone has very ably presented the evidence in favor of the adoption of the 'first species' method of fixing types of composite genera.[1] As a strenuous advocate for many years of the 'elimination' method, I beg space for a few comments on Mr. Stone's paper.

[1] "The Relative Merits of the 'Elimination' and 'First Species' Method in Fixing the Types of Genera—with Special Reference to Ornithology," SCIENCE, N. S., Vol. XXIV., No. 618, pp. 560–565, November 2, 1906.

It must be admitted that he has made a pretty favorable showing for the 'first species' principle. I have always conceded that this would be the ideal method if we were at the threshold of our work, and my opposition to it has always been due to the fact that we did not begin in this way, and that to adopt it now would introduce serious confusion in nomenclature. Mr. Stone's researches in the matter seem to have convinced him that the rigid and uniform enforcement of either principle would result in practically the same number of changes in generic names; while the alleged ease and simplicity in application seems to render the 'first species' method preferable to the 'elimination' process. I regret, however, that in his enthusiasm for his view of the case he has been (doubtless unconsciously) led into a few misleading statements with regard to the ease of its application and to various other matters, only a few of which, owing to the vastness of the subject, can be here noticed. First, he makes the astounding statement that "Elimination has never been practised in Europe and does not seem to be understood by foreign writers, and in the vast majority of cases the first species is taken by them as the type." The implication is that the 'first species' principle not only now prevails abroad, but ever has been the guiding rule in selecting types of composite genera when no type was specified. The truth of the matter is just the reverse! The B. A. Code of 1842 expressly provided that when no type was clearly indicated the author who first subdivided a composite genus might restrict the original name to such part of it as he might deem advisable, and that such assignment should not be subject to subsequent modification. This ruling has been one of the corner-stones of all subsequent codes, down even to the latest, 'The International Code' of 1905. The elimination principle followed as a necessary corollary, and has been used, consciously or unconsciously, with a few individual exceptions, by all subsequent naturalists, in dealing with the question of types, unlimited evidence of which could be cited did space permit. The B. A. Committee suggested, however, that 'in many cases' it might

be 'correctly inferred' that the first species was regarded by the author as the type of his genus, provided that it proved 'accurately to agree' with the definition of the genus. At the same time, the principle of tautonomy, only recently formally adopted, and only by a few authors,[3] was foreshadowed as an important aid in determining types, and whenever in this way a certain species was distinguished from the others, the B. A. Committee ruled that this particular species 'must be regarded as the original type of a genus,' and in case some other species had been taken as the type, 'we are justified in restoring the name of the old genus to its typical signification, even when later authors have done otherwise.' It was recognized also that by invariably taking the first species as type, the author's real intention in establishing a genus might be annulled. While some authors are known to have placed their typical species first on the list, it is known that others gave it a central position.

The method of determining generic types, abroad as well as in America, has not been uniform, but has often been done loosely and without rigid system of any sort: and hence the present confusion. While some authors may have consistently followed the first species principle, and other may have done so occasionally to tide over an emergency, the first species rule has never been incorporated into any code of zoological nomenclature, while the elimination principle has ever been a basic principle in all—not in express terms, but as an inevitable result of the rules for determining types. Consequently, the large number of originally composite genera having the first species as type, shown by Mr. Stone's statistics, is the result of coincidence rather than the conscious application of a 'first species' principle.

It has been claimed that a large number of 'minute rules' are necessary for the application of the principle of elimination, a point emphasized by Mr. Stone in his reference to Dr. Stiles's method, which is by no means so complicated and abstruse as Mr. Stone's passing reference to it would imply. As I have said in another connection:

> The method of fixing generic types by elimination is merely the process of applying the rule of priority to genera formed by the breaking up of comprehensive groups originally designated as genera. It has been objected to as abstruse and difficult of application, even by some who have, but unconsciously, been in the habit of using it. * * *
>
> (*a*) An author who first subdivides a genus may restrict the original name to such part of it as he may judge advisable, and such assignment shall not be subject to subsequent modification (=A. O. U. Code, Canon XXI.).
>
> (*b*) When, however, any of the original species of a genus have been removed by subsequent authors, and have become types of, or are strictly congeneric with the types of, other genera, without the designation of any of them as the type of the original genus, the type must be chosen from the remaining species; if, however, all have been removed, the last species thus removed shall be taken as the type of the original genus. If, however, the genus originally contained both exotic and non-exotic species—from the standpoint of the author—and the generic term is one originally applied by the ancient Greeks or Romans, the last of the non-exotic species to be removed shall be taken as the type of the original genus.

This is the elimination method—simple and perfectly easy of comprehension, but liable to give rise to perplexing complications through questions of synonymy, arising from the fact that certain groups that have been separated and named as generic are treated by some authors as genera and by others relegated to synonymy. It necessitates, however, a thorough knowledge of the literature of the cases involved, and of the zoological relationships of all the species concerned in the inquiry. It is, therefore, not a task a novice should meddle with; but there is no prohibitory law against incompetents, to whose meddling in the past our present state of uncertainty in not a few cases is due.

On the other hand, according to Mr. Stone's presentation of the case, it is perfectly easy for anybody able to read to determine the type of a genus. He says: "It is necessary to consult only the original reference to ascertain the type of the genus." "The question

[3] See SCIENCE, N. S., Vol. XVI., pp. 114, 115, July 18, 1902.

is settled independently for each genus, the result does not depend upon the fixing of the type of some other genus." Again he says: "That we have in the 'first species' rule a method that can lead to but one result and can be practised by any one, and by which the type of a genus can be ascertained at once by consulting one reference, instead of involving the examination of many works and the expenditure of much time and thought."

Unfortunately, this method is not always so simple and direct as here stated, as the citation of a single instance from among many will show. The case of the Linnæan genus *Vultur*, I find, has given a correspondent of mine some trouble in trying to determine the type by the 'elimination' method, and in despair he fell back on the 'first species' principle as the only way out of the difficulty open to him. This case will also show that an intimate knowledge of the literature of the subject is sometimes necessary, and that more than 'one reference' must be consulted even under the 'first species' rule. *Vultur* is also a genus the currently accepted type of which must be changed in any event, whether the 'first species' or the 'elimination' method be employed.

Vultur,[3] as originally established, contained six species, each of which, in the course of time, became, from the standpoint of current nomenclature, the type of a distinct genus, leaving no species in the original genus *Vultur*. The species now currently recognized as the type was not described till eight years after the genus was founded, and hence under all codes is inadmissible as its type. The species originally included in *Vultur* are:

1. *gryphus*,
2. *harpyja*,
3. *papa*,
4. *aura*,
5. *barbatus*,
6. *percnopterus*.

They were removed to other genera in the following order:

1784, *barbatus*, as type and only species of *Gypaëtus* Storr.

1806, *gryphus* and *papa* to *Sarcorhamphus* Duméril.

1808, *percnopterus*, as type and only species of *Neophron* Savigny.

1811, *papa* and *aura* to *Carthartes* Illiger.

1816, *papa* and *gryphus* to *Gypagus* Vieillot.

1816, *harpyja*, as type and only species of *Harpia* Illiger (preoccupied), vice *Thrasaëtus* Gray, 1840.

Of the genera formed from *Vultur* three—*Gypaëtus*, *Neophron*, and *Harpia*—were originally monotypic and require at this point no further consideration. *Sarcorhamphus* consisted originally of three species, indicated by vernacular names, namely:

1. Le condor = *V. gryphus* Linn.
2. Le papa = *V. papa* Linn.
3. Le ouricou = *V. auricularis* Daudin, 1800.

Carthartes originally contained two species:

1. *V. papa* Linn.
2. *V. aura* Linn.

Taking the 'first species' rule, and the assurance that 'It is necessary to consult only the original reference to ascertain the type of the genus,' we arrive at the following results:

The type of *Vultur* must be *gryphus*, the first species.

The type of *Sarcorhamphus* must be *gryphus*, the first species; *Sarcorhamphus* thus becomes a synonym of *Vultur*, it having the same type.

The type of *Cathartes* must be *papa*, the first species.

The type of *Gypagus* must be *papa*, the first species; *Gypagus* thus becomes a synonym of *Cathartes*, it having the same type.

Taking all the species involved in the case of *Vultur*, the nomenclature resulting from the application of the first species rule, compares with that now current, as follows:

First Species Rule.	Current Names.
Vultur gryphus,	*Sarcorhamphus gryphus*.
Cathartes papa,	*Gypagus papa*.
Œnops aura,	*Cathartes aura*.
Ægypius monachus,	*Vultur monachus*.
Otogypus auricularis,	*Otogyps auricularis*.

By this method two genera are reduced to synonymy and the generic designation is changed for four species.

Under the principle of elimination the case works out as follows:

[3] Linnæus, 'Syst. Nat.,' 10th ed., 1758, p. 86.

Sarcorhamphus, 1806; species: *gryphus, papa, auricularis.* The species *papa* was removed to *Cathartes* in 1811, *gryphus* to *Gypagus* in 1816, leaving *auricularis* as the type of *Sarcorhamphus.*

Cathartes, 1811; species: *papa, aura.* The species *papa* was removed to *Gypagus* in 1816, leaving *aura* as the type of *Cathartes.*

Gypagus, 1816; species: *papa, gryphus.* The species *gryphus* was removed to the genus *Gryphus* (Bonap.) in 1854, leaving *papa* as the type of *Gypagus.*

Gryphus, 1854; species: *cuntur* Dum. (= *gryphus* Linn.), *californianus.* By both tautonomy and elimination, *gryphus* is the type of the genus *Gryphus*, as *californianus* became the type of *Gymnogyps* Lesson in 1842.

Recapitulation:

1784. *Gypaëtus*—type *barbatus.*

1808. *Neophron*—type *percnopterus.*

1811. *Cathartes*—type *aura.*

1816. *Gypagus*—type *papa.*

1816. *Harpia* (vice *Thrassaëtus*)—type *harpyja.*

1850. *Gryphus*—type *gryphus.*

As *gryphus* was the last species removed from the genus *Vultur* it is its type by elimination, as well as by the 'first species' rule.

The nomenclature resulting from the elimination method for all the species involved in the case of *Vultur* compares with current nomenclature as follows:

By Elimination.	Current Names.
Vultur gryphus,	*Sarcorhamphus gryphus.*
Gypagus papa,	*Gypagus papa.*
Cathartes aura,	*Cathartes aura.*
Ægypius monachus,	*Vultur monachus.*
Sarcorhamphus auricularis,	*Otogyps auricularis.*

The result is, by coincidence, the same as regards the type of *Vultur* by both methods, but two genera long in current use are conserved.

If, in the case of *Vultur*, the first species had been *barbatus* instead of *gryphus*, the 'first species' rule, if enforced, would conflict with the universally accepted rule that a monotypic genus takes its sole species as its type, thus throwing out the genus *Gypaëtus*, based on the first species removed from *Vultur.* In other cases just this state of affairs is undoubtedly to be expected, in some instances.

There are four conditions, any one of which, when present, determines the type of a genus beyond appeal, under current usage:

1. A genus that is monotypic when founded necessarily takes its only species as the type.

2. When the type is designated by its author at the time of founding the genus.

3. When the name of the genus is the same as that of one of its species, or like that of a synonym of one of its species, or is based upon such a name—in other words, by the rule of tautonomy.

4. When some subsequent author has selected one of its species as its type.

As shown by Mr. Stone, nearly 75 per cent. of the bird genera come under one or the other of the first three of these provisions; and this ratio would probably hold good for most of the other classes of animals. This leaves only about one quarter of the names of zoological genera open to more or less doubt, or within the scope of some special rule for the fixation of types. So that whatever rule may be adopted, a comparatively small number of genera will be affected by it. Contrary to all codes of nomenclature, and in defiance of almost universal usage, Mr. Stone ignores the fixing of a type by a later author than the founder of the genus; this needlessly increases the number of open cases by from probably 50 to 75 per cent.

The trouble with elimination is that the manner of its application has never been properly defined, leaving those who attempt to apply the principle largely to their own devices as to the method of its use. Only experts, or those endowed with a natural cleverness in handling such questions, have been able to apply it with proper discretion and success. The A. O. U. Code simply says (Canon XXIV.): "When no type is specified, the only available method of fixing the original name to some part of the genus to which it was originally applied is by the process of elimination, subject to the single modification provided for in Canon XXIII." This is to the effect that if a "genus contains both exotic

and non-exotic species—from the standpoint of the original author—and the generic term is one generally applied by the ancient Greeks or Romans, the process of elimination is to be restricted to the non-exotic species." This provision was intended to prevent the incongruity of applying an ancient Greek or Latin name to species wholly unknown to the ancients, and thus using it in a grossly inapplicable sense. This, however, is an unnecessary provision, inasmuch as one of the fundamental rules of all modern codes is (A. O. U. Code, Canon XXXI.): "Neither generic nor specific names are to be rejected because of barbarous origin, for faulty construction, for inapplicability of meaning, or for *erroneous signification.*" Since under this rule we tolerate all sorts of absurdities and inconsistencies in names, why should we make this single exception to guard against a mild incongruity? Why, in other words, 'strain at a gnat and swallow a camel'? As this provision is open to diversity of construction in regard to what are 'non-exotic species from the standpoint of the author,' it should by all means be eliminated. If enforced in the case of *Vultur, gryphus* could not be its type. If abrogated, the method of elimination is simplicity itself, as is clearly shown in a later paragraph of this paper. The framers of the code were apparently themselves so familiar with the elimination principle that the necessity of prescribing rules regarding the method of its use for those less fortunate in this respect did not occur to them. It is, therefore, not to be wondered at that in inexpert hands dissimilar results follow its faulty application. Dr. Stiles's rules and suggestions, referred to by Mr. Stone, relate only in small part to the method of elimination; they cover the whole field of the determination of generic types, including the 'four conditions' enumerated above, and relate mainly to a single one of them, being suggestions for the selection of types under the prerogative of the 'first reviser.'

Much of the perplexity and uncertainty in determining types by the elimination method is unjustly ascribed to it, being due to the lack of conviction on the part of authors as to just what groups that have been awarded, by one author or another, the rank of genera are or are not entitled to such recognition, and to the complications of synonymy that necessarily result from this uncertainty. The application in such cases of the first species rule instead of the elimination method does not in the least help the matter, as is obvious from the nature of the case. Yet the onus of the trouble has time and again been saddled on elimination.

Elimination, properly applied, is an exceedingly simple and definitive process. We have a genus, composed originally of several species, the type of which it is necessary to determine.

(1) Species added subsequent to the founding of the genus are excluded from consideration. (2) If some or all of the original species have been made the types of other genera, or are strictly congeneric with such types, they can not be taken as the type of the original genus, unless all have been so removed, when the last species thus removed becomes the type. (3) If only a part have been removed, the type is to be selected by the reviser from those that remain. (4) If none have been removed, any one of them may be taken as the type, at the discretion of the reviser—either the first species or any other.

By the first species rule the work of the first reviser is eliminated; hundreds of genera which have had their types thus fixed are in current use, and in many cases have been in current use for decades, and to displace them through the introduction of a new rule would cause great and needless confusion. The tendency has been, during recent years, to preserve old names, whether generic or specific, wherever possible.

By the first species rule, if the first species is unidentifiable in a genus originally containing a number of species, but for which the founder gave no type, the genus is eliminated as having no standing, although the type may have been fixed by some later author, and the genus be in good standing under current rules of nomenclature.

By the first species rule, where the first species happens to be the same in two or more

genera, no matter how differently the genera may be constituted—whether containing two species or a much greater number—all the later genera become pure synonyms of the earliest genus, necessitating the giving of new names to the later genera and the consequent changing of the generic designation for all the species contained in them.

It is thus evident that Mr. Stone's statistics greatly underestimate the number of changes in names that would result from the adoption of the first species rule.

In a footnote (*l. c.*, p. 561) Mr. Stone suggests that in the case of Linnæan genera we may accept them arbitrarily, inasmuch as there is 'practical unanimity of opinion' as to their types. This may be true as regards birds, and possibly some other groups, but it is not true in general. The A. O. U. Committee, if it sees fit, and is so authorized by the A. O. U., can adopt such a rule with reference to the A. O. U. Check List of North American birds, but there is no assurance that such a ruling would be generally adopted by other ornithologists, while the contrary is quite certain as to zoologists at large. The appalling results that would follow the adoption of the first species rule without such a reservation might force its adherents to its adoption, since otherwise its strict enforcement would result in such radical changes as the transference of many Linnæan genera to other families than those with which they are now associated, and entail also the changing of many family names, and bring in endless confusion in nomenclature instead of the stability we all profess to be striving to secure.

Mr. Stone in his endeavor to show "the various ways in which 'elimination' is applied in practise," publishes a series of hypothetical questions sent out by him to various naturalists, with a summary of their replies. These show practical unanimity in only about 50 per cent. of the cases, and that in many others the answers were widely divergent. The real cause of the discrepancy is not difficult to discover. The questions were stated in so ambiguous a manner that they were open, in a number of instances, to diverse interpretations. I have met personally at least one third of those who sent replies, and thus know that in several cases two and sometimes three different interpretations were put upon the same question. If actual cases had been cited, with proper references to the book and page, so that the real conditions could be studied, it might then have been claimed that a real test had been made of how 'elimination' works in practise.

One of the most surprising statements in this remarkable paper is the assertion: "Elimination has never been practised in Europe and does not seem to be understood by foreign writers, and in the majority of cases the first species is taken by them as the type." The history of nomenclature gives no warrant for such a statement. In the first place, the first species rule has never been included in any zoological code. On the contrary, the provisions for determining generic types either expressly prescribe elimination or distinctly involve that method. The 'Proceedings' of the fourth International Zoological Congress, held in London in 1898, includes a report, some 70 pages in length, of an *International* Committee of Entomologists on the 'Nomenclature of Lepidoptera.' The burden of the report is *any method except the first species rule.* One prominent entomologist says: "The selection of the first in the list of those originally included has no justification whatever; we might as well choose the last, and better the middle one. The species placed first is usually not the most typical but the most exceptional."

The first species rule has been tried in the past and found wanting. More than half a century ago it was adopted by prominent leaders in different branches of zoology, particularly in ornithology and ichthyology; they secured a small following, which soon dropped away, leaving only here and there, among the older authors, a disciple who consistently persisted in its use.

'Elimination,' or the rule of priority method, is interwoven throughout the whole fabric of nomenclature. It is practised everywhere in delimiting the 'type form' in a heterotypic species, in which the earliest name is reserved for the form first described. Here.

as in the determination of generic types, elimination is simply the application of the most fundamental of nomenclatural rules, *the law of priority*.

J. A. ALLEN.
AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK.

MISREPRESENTATIONS OF NATURE IN POPULAR MAGAZINES.

IN the December number, 1906, of *The Wide World* E. W. G. Wesson claims to have passed by boat on the Colorado River through the Grand Canyon. The greater part of his descriptive matter has been taken, paragraph by paragraph from R. B. Stanton's account of the descent made years ago by Stanton's second party, and of the descriptions which are original with Wesson, some are so original as to be totally outside of the realm of truth.

That he never made the journey which he claims to have made is evident, and the magazine which publishes such falsehoods does much harm and discredits itself.

A. R. CROOK.

SPECIAL ANATOMY AND PHYSIOLOGY OF THE GASTEROPODA OF THE UNITED STATES—LEIDY. A CORRECTION.

TO THE EDITOR OF SCIENCE: Through an oversight when preparing a bibliography of the late Professor Joseph Leidy's contributions to science, published (1904) under the auspices of the Smithsonian Institution and incorporated in a publication under the title 'Researches in Helminthology and Parasitology by Joseph Leidy, M.D., with a bibliography of his contributions to science,' 1904, the writer neglected to incorporate the title to a work on the 'Special Anatomy of the Gasteropoda of the United States,' Boston, 1851, pp. 65, plates 16, published in conjunction with the work of Amos Binney and W. G. Binney, entitled 'Terrestrial Breathing Mollusks of the United States and Adjacent Territory of North America,' edited by A. A. Gould, Boston, 1851–9.

The work of Leidy devoted to the special anatomy and physiology of various gasteropod mollusks may be found in section 11, Vol. I.

The writer regrets the oversight, particularly as it is a work to which frequent reference is made by investigators along similar lines of research, and more so since the publication was well known and special care was taken to see that it appeared in the original bibliography.

JOSEPH LEIDY, JR.

EARLY TYPES OF MAN IN IOWA.

TO THE EDITOR OF SCIENCE: In connection with the article on the discovery of an early type of man in Nebraska, I wish to call attention to what seem to be similar types from mounds in Iowa. In the proceedings of the Davenport Academy, Vol. VI., is a paper by Professor Frederick Starr on a 'Summary of the Archeology of Iowa,' in which are figured two skulls, said to be of the Neanderthal type. One of these was found in a mound in Chickasaw County and the other in Floyd County. While it is difficult to decide from the illustrations, as to whether these skulls are of the Neanderthal type, it is obvious that they bear striking resemblances to it. It is also suggestive that these skulls should be found west of the Mississippi and in a part of the same geographical area from which comes the Nebraska man.

C. W.

MALAY AND FILIPINO BASKETRY.

TO THE EDITOR OF SCIENCE: No doubt this will fall under the eyes of more than one who has examined Malay or Filipino basketry. Everywhere in Malaysia is to be found a knot in coarse or fine splits and stems of tough and pliable plants, used in place of nails, screws, pegs and the like. This knot is practically two round turns and two half hitches. It may be described thus: (1) Pass the free end of the split or other binder toward the right to where the knot is to be tied; (2) then under and around these parts and behind the standing-part; (3) pass the free end again around in the same direction, bringing it this time in front of the standing-part and under the two round turns toward the right; (4) take a half hitch around the standing-part

from down upward and make all tight. Repeat at will, working always toward the right. I am now writing up the Dr. W. L. Abbott basketry, from southwestern Malaysia, and desire to use nomenclature that will stand for the Philippines, where the 'Malay knot' is in vogue. The trouble with the name is twofold, there are other Malay knots and other peoples who use the same knot. Perhaps 'Malay double hitch' would be better, but it is somewhat nautical.

O. T. Mason.

THE RIGIDITY OF THE EARTH.

Professor See's computation of the mean hydrostatic pressure within the earth, deduced from Laplace's law of density, is doubtless correct. That the modulus of rigidity is equal to the hydrostatic pressure is, however, purely an assumption.

L. M. Hoskins.

Palo Alto, Cal.,
November 10, 1906.

THE LIGHTNING-ROD COINCIDENT WITH FRANKLIN'S KITE EXPERIMENT.

A file of the *Pennsylvania Gazette* for the year 1752 furnishes facts which corroborate my conclusions, in Vol. XXIV., pages 374–376, that the lightning-rod was in use about the time Benjamin Franklin flew his electrical kite. The supposition there discussed, that the news of the successful experiments in France by MM. Dalibard and Delor during the month of May did not reach Philadelphia in June, during which month Franklin is said to have brought down electricity from the clouds, is supported by the fact that a letter from Paris describing the French experiments, and dated May 26, N. S., 1752, was not published in the *Pennsylvania Gazette* until August 27 of the same year.

That Franklin did not fly his kite until later in the summer than June is likewise indicated by the circumstance that the first account of the experiment appeared in the *Gazette* of October 19. This account is identical with the oft-quoted letter to Peter Collinson, which was read before the Royal Society in December and printed in the *Philosophical Transactions*, excepting that it lacks the closing statement about the experiments in France with 'points' and their prior use in America.

Finally, my assumption that the directions for erecting lightning-rods, which appeared in *Poor Richard's Almanac* for 1753, must have been written not later than October, 1752, is proved correct by an advertisement in the *Gazette* of October 19, stating that this issue of the *Almanac* was in press and would be published shortly.

The collateral evidence here adduced favors the belief that Franklin performed his kite experiment some two months later than has been supposed, and proves conclusively that at the time when it was first described Franklin had already prepared for publication precise directions for placing lightning-rods upon all kinds of buildings.

A. Lawrence Rotch.

Blue Hill Meteorological Observatory,
November 15, 1906.

SPECIAL ARTICLES.

NOTICE OF A NEW MIOCENE RHINOCEROS, DICERATHERIUM ARIKARENSE.

The accompanying sketches represent the skull of a species of rhinoceros, *Diceratherium arikarense*, supposedly new, discovered by the geological expedition of 1905, sent from the University of Nebraska by the Hon. Charles H. Morrill to the Loup Fork beds at Agate, Nebraska, on the ranch of Mr. James Cook.

The genus *Diceratherium* was established by Marsh in 1875 on material from the Miocene beds near the John Day River in eastern Oregon, and two species, *armatum* and *nanum*, were recognized. A third species, *advenum*, was based on material from the Eocene (possibly Miocene) of Utah. Difference of horizon, and distance seem to warrant the specific name herein proposed. In comparing numerous individuals such variation was noted as to justify the belief that this group might legitimately enough be divided into several species.

The figures seem sufficiently explanatory, so descriptions will be brief. A pair of anterior protuberances or horn cores constitute the dis-

tinguishing feature of the genus. Many skulls were found, but unfortunately no single one was complete. They were found in a very limited area, and together with them were great numbers of rhinoceros bones, many of *Syndyoceras, Oxydactylus,* a species of horse, tapir, rhinoceros, etc., being associated constitute an interesting new fauna for the region.

Dental formula: I 1/?, C ?/0, P 4/3, M 3/3.

Measurements: Length of skull, 375 mm.

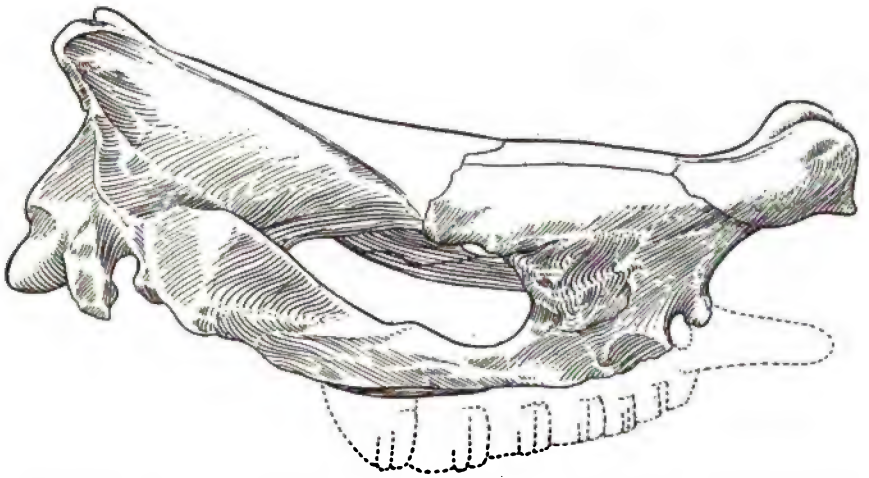

FIG. 1. Skull of *Diceratherium arikarense,* side view, drawn from a specimen in the collections of Hon. Charles H. Morrill.

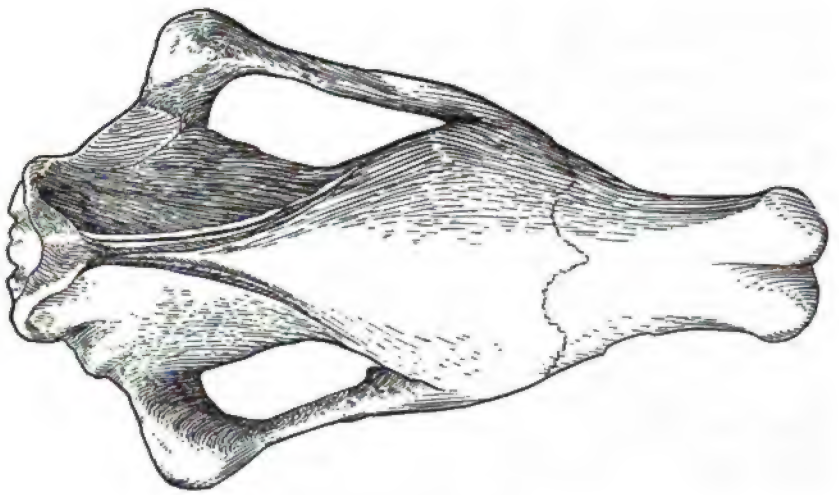

FIG. 2. Top view of the above.

which presumably belong to this genus, in which event a complete restoration is assured. The mandible is strong, and its angles are expanded and flare outward. Some crania are so short and saddle-shaped that they must belong properly to another species.

Diceratherium, Elotherium, Chalicotherium, (14.75 inches); extreme width across zygoma, 220 mm. (8.75 inches); distance between postorbital processes, 130 mm. (5 inches); width across horn cores, 68 mm. (2.75 inches).

ERWIN HINCKLEY BARBOUR.
THE UNIVERSITY OF NEBRASKA,
July 4, 1906.

THE TERM 'COLLUVIAL' AS APPLIED TO CLAY DEPOSITS.

WHILE investigating clay deposits in the northern part of Georgia, my attention was called to a large number of recent deposits of some economic value, which were neither residual nor alluvial in origin, and in attempting to classify them the need for a special term was apparent. The term 'colluvial' is proposed to designate a type of clay deposits which occur in sinks or depressions and at the foot of slopes. The term 'colluvial' is used by G. P. Merrill[1] to include talus and cliff débris, and the soil resulting therefrom. By extending somewhat the meaning of the term as used by Dr. Merrill, the particular type of clay deposits in question can be included under it. The term, in connection with clay deposits, has been very little used, but deserves recognition, both from a scientific and economic view point.

Colluvial clay deposits differ from residual deposits in that they have been transported, and from alluvial deposits in that they have not been carried in suspension by streams and are not flood-plain deposits. They occupy a position midway between residual and alluvial deposits, and may, by gradual transition, pass into either. They are due to the transportation of residual material, by gravity and wash, to the foot of slopes.

The factors in the formation of colluvial clay deposits are: surface decay of rock masses, producing residual deposits, transportation of this residual material by gravity and wash, and rearrangement by mechanical and chemical changes. To illustrate the formation of a deposit take as an example a hill of residual material derived from a crystalline rock. The section of this residue is, beginning at the top, red clay soil containing coarse quartz fragments, yellow to gray clayey residue, disintegrated rock, and, finally, unaltered rock. By wash by rain water, the finer clay and mineral particles of the residue are carried furthest and lodged at the slope of the hill, forming the clay deposit. In granite regions, the clay at the foot of a slope may be almost white, gradually changing into the red and yellow soil higher up the slope.

An analysis of one of these colluvial clays, from a granite region, is:

Moisture at 100° C.	2.462
Loss on Ignition	8.654
SiO_2 (total)	60.110
SiO_2 (sand)	31.150
Al_2O_3	24.256
Fe_2O_3	2.080
CaO	.110
MgO	trace
MnO	trace
Na_2O	.262
K_2O	1.647
TiO_2	.754
Total	100.331

OTTO VEATCH.
GEOLOGICAL SURVEY OF GEORGIA.

[1] 'Rocks, Rock Weathering and Soils,' p. 319.

QUOTATIONS.

'BOTANY IN ENGLAND': A REPLY.[1]

IN the September number of the *Journal of Botany* Mr. James Britten deals at considerable length with the portion of my presidential address to the botanical section at the recent meeting of the British Association at York, which was printed under the title 'Botany in England.'

As Mr. Britten's criticism seemed based on a misapprehension of the drift of my remarks, and as it was printed in a medium often consulted by systematic botanists, I naturally sent a reply which I hoped might be inserted in a forthcoming number of the same journal. In his capacity as editor, however, Mr. Britten did not see his way to insert my reply in the form in which I had written it. As I was unable, in my turn, to fall in with the restrictions imposed by Mr. Britten, hospitality for a rejoinder had to be sought elsewhere. It is under these circumstances that the present note appears in the pages of the *New Phytologist*.

Whilst welcoming any criticisms that Mr. Britten may think fit to make, I may, perhaps, be permitted to express the hope that the tone which animates his recent utterance may find

[1] From *New Phytologist*, Oct., 1906, pp. 173–176.

no permanent place in botanical controversy. When one's shortcomings are so rudely exposed there is the temptation to emulate one's critic and take reprisals.

In my York address I endeavored to show that in the general advance of botany in this country during the last twenty-five years our great centers of systematic botany had become incased, as it were, in a sort of water-tight compartment, and this from causes inherent in their organization. I do not think it can be seriously questioned that the herbaria pursue their work apart. One has only to turn to the utterances of men so well qualified to speak for systematic botany as Sir George King and Sir William Thistleton-Dyer. The former speaks of its neglect and decadence; in his presidential address to Section K, British Association, Dover, 1899, p. 16, the latter refers to its decline as a 'serious peril.' It is not even an open secret, it is common knowledge. Mr. Britten, when his remarks are stripped of the irrelevancies and innuendoes which adorn them, tells us in effect that my apprehensions are groundless and that systematic botany jogs on happily without the schools. Now this is dangerous optimism, or it would be if taken seriously.

The position seems to be this: rightly or wrongly and in spite of warnings we are permitting the herbaria to become stranded: the universities, schools and other institutions which diffuse and stimulate an interest in botany are not laid under contribution as they might be. Systematic botany hardly gets its fair proportion of the best that is available. To my mind this is a great misfortune, a source of weakness; nor do I believe I am indiscreet in ventilating the subject. My critic would say, perhaps, 'Teach systematic botany by all means and then send your people on to us.' But that is not the way to get recruits worth having. A mere pious opinion in favor of a given branch of knowledge will effect nothing, even if you put your precepts into practise. If one takes stock of the various places which are centers of activity in turning out students equipped and keen to pursue science, one finds, with hardly an exception, that those who guide these institutions place original investigations in the forefront. Heads of departments are selected largely on the strength of their qualifications for research, and so far as circumstances permit support is afforded for its prosecution. Hence, if the great school of systematic botany is to be revived in this country, the systematists themselves, *i. e.*, those with the equipment of the great herbaria behind them, must take the leading share in the campaign. This was my principal contention at York, and I do not think matters will be remedied until the herbaria become attached or related in some way to the educational system. Unless our work is to be sterile we must take our share in training those who are to come after us. Robert Brown and Sir Joseph Hooker are exceptions to every rule: if only we could control genius in respect of time and place of its appearance, all would be well; but experience shows that we have to depend on the normal, and that these two men were not normal is shown by the fact that none like them have been produced for the past half century.

I should like to see members of herbarium staffs *ipso facto* members of the neighboring university, or, at any rate, a selection from among them. It may be urged that if the systematist is to discharge professorial functions it must be at the sacrifice of some of the duties which he at present performs. This is very true. But it was one of my points that much of the routine work which falls to his lot is within the capacity of subordinates. You want two classes in a herbarium: the scientific workers who really advance the subject, and subordinates who would carry on a great deal of the routine work. The former would be free not merely to write monographs, etc., along the accustomed lines, but also to open up new lines of attack on old problems. If ever there was a time when the future of systematic botany was full of promise, it should be the present. The perfecting of cytological and anatomical technique and the improvement in breeding methods place new implements at its disposal for broadening and deepening its work. Botanists should pull together with a view to so modifying the

system that we in this country may take our proper place in the general advance. If we look abroad to centers of activity in systematic work, I think we shall find the relation between the university, the herbarium and the garden, to be an important factor in the case.

When Mr. Britten says I would have botany the sole possession of the schools, he falls into error. He depicts me as one who would lock the door and have a bonfire. His readers may rest assured that the unique and precious collections of our herbaria will suffer no hurt should 'men of my stamp' ever get a finger in the pie; nor would the interests of the various classes who consult them be prejudiced. Possibly Mr. Britten has allowed himself to be misled by a too literal interpretation of figures somewhat incautiously employed. My meaning was this: We must not be afraid to go ahead and if necessary modify the line of attack on systematic problems, even if by so doing our present collections should cease to hold the same relative scientific value that they now are supposed to possess. They will always retain their interest; whilst their historic value will ensure their being cherished.

To read his words one might suppose violent annexation of the herbaria and their custodians had been advocated. But if Mr. Britten will turn to my address he will find nothing more revolutionary than a proposal for a working arrangement.

These things, alas, are not burning questions—like district railway fares and the Times Book Club. Some day let us hope a minister will arise; one who sees and cares. The readjustment will be effected without a revolution and the only wonder will be that we remained so long on the old lines.

Regarding the question of fusion of the herbaria of Kew and the Natural History Museum, surely this ancient proposal (which Mr. Britten tells us dates from 1848) may be discussed without emotion. In any case it is of relatively secondary importance and the case for it rests largely on the need of utilizing effectively our resources. My motive in raising it in my address was the knowledge that unless you pack something concrete into the loading of your gun, the smoke clears off and there is no effect.

On its merits and for reasons already advanced I am disposed to view the proposed fusion with favor, though age and wisdom, according to my critic, are ranged on the other side. As a site, Kew seems preferable for the united herbaria in view of the contiguity of the gardens, which offer such unlimited facilities for the attack of systematic problems from the cultural side. The disadvantage of distance is less serious than Mr. Britten supposes, for the students who, it is contemplated, would avail themselves of the improved facilities would be mainly of the post-graduate type, devoting the whole of their time to systematic botany. The question of 'openings for trained students,' by which Mr. Britten means remunerated posts was never raised by me in this connection. It is remarkable what a number of persons, thoroughly trained, remain in the universities carrying out original investigations for love of the thing, often making considerable sacrifices so to do. This is a hopeful sign for the future of science, and it affects botany in common with the other sciences. Perhaps Mr. Britten will consider whether it is worth while for the herbaria to lay this source under contribution. All the same, I fully appreciate Mr. Britten's point when he thanks heaven that the museum is managed by trustees. In so far as the trustees may be regarded as a sort of half-way house between a government office and a university, that is something to be thankful for. Once you make connection between the systematic institutions and the university, the new growth will begin. In time the university will be worthy to enter more fully into the possession of its heritage. Of course an immense part of the work of Kew must remain outside direct university influence. All the same my dream of the future is a modified Kew discharging its economic and imperial functions, and at the same time supporting a great university department. It may not be realized in our time; its development at best must be slow; what we want is a beginning, towards which, indeed, the way is mostly paved. F. W. Oliver.

CURRENT NOTES ON METEOROLOGY.

PERUVIAN METEOROLOGY.

THE meteorological work of the Harvard College Observatory in Peru has frequently been brought to the attention of the readers of SCIENCE in these notes, especially during the visit of the present compiler of these notes to South America in 1897–8. In 1899 there was published the first volume on 'Peruvian Meteorology, 1888–1890,' containing observations made at Mollendo, Arequipa, Vincocaya, Puno and near Chosica (*Annals Harv. Coll. Obs'y*, XXXIX., Pt. I.). In this same volume there was an account of the volcano El Misti, on whose summit there was maintained for some years the highest meteorological observatory in the world, and also a paper on the configuration and heights of the Andes. Both of these chapters were written by Professor Solon I. Bailey, and the compilation and reduction of the observations was also carried out by him. We now have a second publication, entitled 'Peruvian Meteorology, 1892–1895' (*Annals Harv. Coll. Obs'y*, XXXIX., Pt. II., 1906), in which there are tabulations of the observations made at Mollendo (80 ft.), La Joya (4,140 ft.), Arequipa (8,050 ft.), Chachani (16,650 ft.), Misti Summit (19,200 ft.), Mt. Blanc (15,600 ft.), Huesos (13,300 ft.), Cuzco (11,100 ft.) and Santa Ana (3,400 ft.). Mollendo is on the seacoast; La Joya is on the Desert of Islay; the Chachani station was, until the establishment of that on the Misti, the highest meteorological station in the world. The so-called Mt. Blanc station is on the flank of the Misti, at about the altitude of the top of Mont Blanc, and the Huesos shelter is on a lofty pampas at the base of the Misti. Cuzco is the old Inca capital. And Santa Ana is beyond the eastern Cordillera, near the limits of civilization. Details concerning the location and establishment of these different stations are given in the introduction, and also a description of the tables. The extraordinary interest which has attached to these meteorological undertakings in Peru, carried on under great difficulties and often also, in the establishment of some of these stations, at considerable risk, has made the meteorological world impatient to have access to the records. This volume will, therefore, be given a warm welcome. In spite of breaks in some records here, and inaccuracies in other records there, the publication is one of unusual value. Excellent views are given of each of the stations; a cross-section shows the relative distances and altitudes in each case, and curves are given in some cases. A discussion of the famous crescentic sand dunes of the desert of Islay will prove interesting to geologists and physiographers. The volume was compiled and prepared for publication by Professor Solon I. Bailey.

CIRRUS AND RAIN.

AT the Royal Observatory of Belgium, in Uccle, Vanderlinden has, for the years 1892–1905, studied the relation between the direction of movement of cirrus clouds and the subsequent occurrence of rain. The directions which are oftenest followed by rain are S.W., W. and N.W. The opposite directions are in the majority of cases followed by days without rain. The latter are, however, seldom observed, and the general result is that, omitting the S.E., E. and N.E. cases, there is almost always the same probability of rain or no rain. The probability exceeds 50 per cent. in the case of the W. and S.W. octants only. Cirrus clouds, then, do not appear always to be the prognostics of rain which they have been said to be. It may be noted that at Blue Hill Mr. H. H. Clayton has shown that cirrus clouds are not, as a whole, an indication of coming rain, but are somewhat less frequently followed by rain than the average probability of rain (*Annals Harv. Coll. Obs'y*, XXX., Pt. IV., 474).

METEOROLOGICAL NOTES IN LABRADOR.

ALTHOUGH the Moravian missionaries on the Labrador coast have supplied remarkably complete series of meteorological data from that region, the interior of Labrador is very little known meteorologically, and even fragmentary accounts are of interest. In an account of 'Labrador, from Lake Melville to Ungava Bay' (*Bull. Amer. Geogr. Soc.*, 38,

1906, 529–539), Mrs. Leonidas Hubbard, Jr., notes that during her trip in June–August, 1905, the weather was very fine. The maximum temperature was 77°. In the higher lake country the clear nights were frosty, and on August 10 a coating of ice an eighth of an inch thick formed on a basin of water outdoors. Snow flurries occurred on three days. Thunderstorms were rare and very mild. Passing showers gave rise to remarkably beautiful rainbows. The clearness of the atmosphere made objects miles away seem very near. The plague of flies and mosquitoes, which is a well-known characteristic of some northern lands in summer, is noted as one of the disagreeable features of the trip.

AFRICA AND THE WHITE MAN.

Reports from Africa note the increase of the white populations in regions which have hitherto been occupied by natives only. Boer farmers are immigrating into the northern part of German East Africa, which is described as an 'elevated and healthful region.' These Boers are chiefly cattle-raisers. Mr. H. Buttengach, a mining engineer who has spent two years in Katanga, the southeastern province of the Congo Free State, is convinced that European colonization is warranted by the climate of this high plateau (*Bull. Soc. Belge d'Etudes Coloniales*, No. 6, 1906), and that agriculture may have great development on these wide alluvial plains. M. Auguste Chevalier believes that the cultivation of cacao will have enormous growth in French West Africa. The seventh report on the German cotton experiments in German Africa (*Der Tropenpflanzer*, No. 6, 1906) shows that the natives are making good progress under German tuition. The prospects in the Cameroons are encouraging in certain districts, as they are in the northern part of German Southwest Africa.

R. DeC. Ward.

PALEONTOLOGICAL NOTES.

FOSSIL CHRYSOCHLORIDÆ IN NORTH AMERICA.

The Chrysochloridæ, or golden moles, are one of the several mole-like types which take the place of the true moles in the southern continents. True moles (family Talpidæ) are found in the subarctic and temperate zones of all the northern continents, but not in or south of the tropics. But in the south temperate zone several animals are known which have adopted mole-like habits, and superficially resemble the true moles to a greater or less degree. In Australia there is a marsupial mole, *Notoryctes;* in Madagascar certain members of the Centetidæ are mole-like; and in South Africa we have the Chrysochloridæ. The latter two families are, like the true moles, included in the order Insectivora, but belong to the primitive or archaic division of Zalambdodonta, while the true moles belong to the more progressive, modernized and dominant group of Dilambdodonta. In South America there are at present no mole-like Insectivores or Marsupials, but in the Upper Miocene (Santa Cruz formation) of Patagonia have been found remains of an extinct mole, *Necrolestes*, of the Chrysochlorid family, most nearly related to the modern Golden Mole of South Africa.

The geographical range of these Chrysochloridæ, limited to the southern extremities of the two southern continents, and their supposed absence from any of the modern or fossil faunas of the northern continents, is not easily explained with the present distribution of land and water on the earth's surface. They form one of several peculiar elements common to the fauna and flora of the two continents which have suggested former land connection, probably *via* the Antarctic continent at a time when the polar climate was comparatively warm and Antarctica a habitable region. There is a considerable weight of evidence for the former connection of Australia and South America *via* Antarctica, but the evidence that South Africa was formerly connected is much weaker, and the geological and physiographic difficulties in the way are much more serious, as a much broader ocean intervenes, of abyssal depth and every indication of long permanency.

The discovery of Chrysochlorid moles in a Lower Miocene formation in North America,

and their probable presence in earlier formations in this country, is therefore of interest in paleogeography, as it further weakens the evidence for the former connection of South Africa with the other southern land masses, by subtracting this family from the common faunal elements peculiar to the two southern continents.

The specimen which enables us to positively identify Chrysochlorid moles from this country was found by Mr. Albert Thomson, of the American Museum Expedition of 1906, in the Arickaree formation (Rosebud beds) south of White River, South Dakota. It consists of a humerus, complete and well preserved but without any other parts of the skeleton. The humerus of *Chrysochloris* is, however, so peculiar and characteristic in form, as described by Dobson (Monograph of the Insectivora) and shown in the figures and specimens with which comparison has been made, that there can be no doubt that the fossil specimen belongs to the family, although somewhat less specialized than the modern genus. Dobson's detailed description (p. 116) of the humerus of the modern *Chrysochloris* applies word for word to the fossil; but his figure and those in de Blainville's 'Osteographie,' as well as the actual skeleton, show a less degree of specialization in several parts. The associated fossils make its age equally certain. Only a small part of the collection has been examined in the museum as yet, but this is amply sufficient to fix the fauna as intermediate between the John Day (Upper Oligocene) and the Deep River (Middle Miocene), and of nearly the same age as the magnificent fossil fauna recently obtained by the Carnegie Museum at the Agate Springs Quarry in Nebraska.

I have for some time suspected that the skull described by Mr. Douglass in 1906 as *Xenotherium* from the Lower Oligocene of Montana, belonged in or near the Chrysochloridæ, which it resembles in a much more significant manner than it does the Monotremes to which it was provisionally referred by the describer. The proof that Chrysochloridæ did inhabit North America in the Middle Tertiary makes it reasonable to refer *Xenotherium* definitely to the same family. *Apternodus* Matthew, from the same formation and region as *Xenotherium*, is probably the lower jaw of that genus or some closely related form. It is possible also that one or more of the Insectivora described by Marsh in 1872 from the Bridger formation (Middle Eocene) may prove to be ancestral types of Chrysochloridæ.

The distribution of this rare and interesting family of Insectivora as now known is:

Modern—South Africa.

Upper Miocene—South America (Patagonia).

Lower Miocene—North America (South Dakota).

Lower Oligocene—North America (Montana).

(?) Middle Eocene—North America (Wyoming).

Insectivora are exceedingly rare as fossils, and this is no doubt but a small fraction of the real distribution of the family during the Tertiary. We can not regard the South American representative in the Upper Miocene as descended from the North American species of the Middle Tertiary, for South America, during the Middle Tertiary at least, was an insular continent, and its mammal faunæ from the early Eocene until the beginning of the Pliocene, contain no elements of northern origin, but develop on entirely independent lines of evolution. It would appear rather that the North and South American chrysochlorids are descended from a common pre-Tertiary ancestor. The modern South African form, on the other hand, may be more nearly related to the North American genera if we suppose that the middle or early Tertiary range of the family extended to Europe and Asia, whence it might readily have reached its present home. All authorities are agreed that Asia and North America were united during most of the Tertiary, and Africa was united to the northern land in the Oligocene and subsequently. Hence there are no geographic difficulties in the way of this supposed wider distribution—nor adequate evidence to take it out of the region of conjecture. In fact, until the mutual relationships of the Chrysochloridæ

of the three continents are determined by exact and thorough comparison of their structure, any explanation of their curious geographical distribution is highly conjectural. It is clear, however, that, as now known, they can no longer be regarded as an exclusively southern group, nor is there any necessity for believing that the South African genus is derived from South America *via* Antarctica. The most reasonable conjecture appears to be that we have here the scattered remnants of a group of very early specialization and wide distribution in pre-Tertiary times, which with the rest of the zalambdodont insectivores and many other archaic types, disappearing before more progressive competitors, found its last place of refuge in the southern continents and the greater tropical islands.

W. D. Matthew.
American Museum of Natural History,
October 25, 1906.

SCIENTIFIC NOTES AND NEWS.

The Nobel prizes were on December 10 awarded as follows: Physics, Professor J. J. Thomson, of Cambridge; chemistry, M. Moissan, of Paris; medicine, Professor S. Ramón y Cajal, of Madrid, and Professor Camillo Golgi, of Pavia; literature, Professor Giosuè Carducci, of Bologna; for the promotion of peace among nations, President Roosevelt.

Mrs. Shaler is preparing to write a life of the late Nathaniel Southgate Shaler, which is to be published in the near future. She has made an appeal for letters or reminiscences that would be useful and has asked that these be sent to her at 1775 Massachusetts Avenue, Washington, D. C.

Under the auspices of the Peary Arctic Club, Commander Robert E. Peary gave an account of the voyage of the *Roosevelt* and his expedition 'furthest north' at the American Museum of Natural History on Saturday afternoon, December 8. Commander Peary was introduced by Mr. Morris K. Jesup, president of the Peary Arctic Club and of the museum. It is said that some thirty thousand people tried to obtain entrance to the hall and to the informal reception which was held after the address. A dinner was given by the Peary Arctic Club to Commander Peary at the University Club on December 12.

M. Mascart will retire from the directorship of the Central Bureau of Meteorology in Paris on January 1. He will be succeeded by M. Angot.

Professor Gariel has resigned the secretaryship of the council of the French Association for the Advancement of Science, a position which he has held for the past thirty years.

Dr. William H. Brooks, director of Smith Observatory and professor of astronomy at Hobart College, Geneva, N. Y., has received a medal from the Astronomical Society of Mexico, for his discoveries of twenty-five comets.

Mr. L. A. Peringuey has been appointed to the directorship of the South African Museum, Cape Town, to fill the vacancy caused by the resignation of Mr. W. L. Sclater.

At the recent meeting of the Association of Teachers of Mathematics of the Middle States and Maryland, Professor Edwin S. Crawley, of the University of Pennsylvania, was re-elected president.

Dr. William J. Mayo, of Rochester, Minn., retiring president of the American Medical Association, has recently been visiting Philadelphia as a guest of the dean of the medical department of the University of Pennsylvania.

The fifth lecture in the Harvey Society course will be given by Dr. S. J. Meltzer, of New York, on Saturday evening, December 15, at 8:30 P.M., at the New York Academy of Medicine, on 'The Factors of Safety in Animal Structure and Animal Economy.' All interested are cordially invited to be present.

Professor Pierre Janet, of the University of France, has delivered three lectures in the Johns Hopkins University on 'Mind and Medicine.'

Dr. Hugo Münsterberg, professor of psychology at Harvard University, has received leave of absence from November 21, 1906, to January 12, 1907, for a visit to Germany.

DR. HIRAM BINGHAM has sailed for Venezuela, where he will make explorations in the region of eastern Colombia.

MR. A. B. STOUT, of Baraboo, Wisconsin, is working out plans for the preservation of the man mound described in his bulletin on the 'Archeology of Eastern Sauk County.' It is the last of the three mounds of that character, and is said to be the only man mound now known to be in existence.

THE Swiss government has awarded a premium of 5,000 francs to Dr. M. Rickli, of Zurich, and Professor H. Bachmann, of Lucerne, toward the expenses of a botanical expedition to Greenland.

A MONUMENT in honor of Servetus is to be erected at Vienne in the department of Isère where he lived for twelve years. It will be remembered that Michael Servet, who was burned at Geneva in 1533 for his theological opinions, discovered the pulmonary circulation and made important contributions to geography.

DR. WILHELM LOSSEN, formerly professor of chemistry at Königsburg, has died at the age of sixty-seven years.

WE learn from the *British Medical Journal* of the death of Dr. Nikanor Chrzonszczewski, sometime professor of general pathology in the University of Kieff, aged seventy; Dr. Lew Pawlow, of St. Petersburg, physician to the Czar and president of the Russian Medical Association, aged fifty-nine; Dr. Plantau, professor of histology in the Medical School at Algiers; Professor Liugu Casati, for many years editor of the *Raccoglitore Medico*, and founder, in conjunction with Professor Ruata, of the Institute for the Orphans of Medical Practitioners at Perugia, aged seventy-six; and Dr. Reincke, who reorganized the public health administration of Hamburg.

THERE will be a civil service examination on December 26, to fill the position of chief of the Laboratory of Physiological Chemistry, in the Bureau of Chemistry, Department of Agriculture, at a salary of $2,500. On January 4, there will be examinations to fill the positions of laboratory assistants, qualified in chemistry, in the Bureau of Standards, at a salary of from $900 to $1,000; and to fill the position of dairy chemist in the Bureau of Animal Industry, at a salary of $1,200 to $1,800.

PROFESSOR RAJNA, of Bologna, is making an appeal for funds to rebuild the observatory there on a new site, and provide it with instruments suited to modern requirements.

PEABODY MUSEUM, Yale University, has received as a gift from Professor Schuchert a collection of antiquities gathered by him during his recent trip through Mexico.

THE annual dinner of the National Geographic Society will be given in Washington December 15. Invitations have been issued by Professor Willis L. Moore, president of the society, and a dinner committee.

THE New York Association of Biology Teachers will hold its next meeting at the High School of Commerce on December 14 at 8:15 P.M. Dr. C. Stuart Gager, director of the laboratories at the New York Botanical Garden, and Dr. M. A. Bigelow, head of the department of biology of Teachers College, will lead a discussion on 'How can secondary school teachers of biology maintain a spirit of investigation while engaged in teaching.'

THE ninth International Congress of Geography will be held at Geneva from July 27 to August 6, 1908.

THE fourth International Congress for the Welfare and Protection of Children will be held in Berlin on May 22–26, 1907.

ACCORDING to foreign papers, the *Journal Officiel* is about to publish statistics of the marriages, births and deaths that took place in France in 1905. The figures show that, while marriages increased as compared with 1904, births fell off, the rate being the lowest on record. In forty-four departments (as compared with thirty-six in the previous year) the deaths were actually in excess of the births, and in certain provinces the difference was enormous, the record being three deaths as against two births. An increase in the death rate helps to aggravate the situation.

Nature states that visitors to the old Swedish cathedral and university town of

Lund will find no little interest in the comparatively recent collections at the ethnographical museum illustrating many phases of rural life. Old peasant houses have been taken down, brought from considerable distances, and set up at Lund, among the buildings being an old church and an inn. Models of interiors of houses with costumed figures of inmates give an excellent idea of rustic conditions, reminding one, though on a smaller scale, of the Cecho-Slavonic museum in the Kinsky Park at Prague.

Professor Charles Baskerville, of the College of the City of New York, has closed a series of six lectures, at the Brooklyn Institute of Arts and Sciences, on physical chemistry under the title of 'The Elements.' The lectures were extensively illustrated with experiments and samples; the subjects treated were the following: (1) Chemistry at Low Temperatures. Stability of the Elements. (2) Chemistry at High Temperatures. Instability of the Elements. (3) Ultra-Violet Light and its Rôle in Chemistry. Production of the Elements. (4) The Methods for Determining the Integrity of a Chemical Element and their Defects. (5) Radium and the Transmutation of the Chemical Elements. (6) Phase Rule and the Elements. Harmonizing of Divergent Views.

The following letter has been received by the Academy of Natural Sciences, of Philadelphia, in acknowledgment of the receipt of books sent to the California Academy of Sciences as a help toward the replacing of the library destroyed by earthquake and fire:

California
Academy of Sciences,
San Francisco.

1812 Gough Street,
San Francisco, Cal.,
November 16, 1906.

Mr. Edward J. Nolan, *Recording Secretary and Librarian,*
Academy of Natural Sciences of Philadelphia,
Philadelphia, Pa.

Dear Sir:—Your letter of September 26th reached us some weeks before the books arrived through the Smithsonian Institution.

You have certainly sent us a magnificent gift, and no pleasanter task has ever been given us than the unpacking and shelving of box after box of such treasures. The shelving capacity of one room in our temporary quarters is taxed to the utmost, and by common consent it is generally referred to as "The Philadelphia Academy room."

We appreciate it all,—your own publications, so complete and so beautifully bound, the magnificent folios, the rare old books, the early volumes of so many valuable sets, the goodly number of works relating to expeditions, some of which we had long desired but had never owned, the great variety of subjects represented by the collection, and the book-plate, the mute reminder of the friends who succored us at the time of our almost overwhelming disaster. And so we thank you, with hearts full of gratitude for your generous gift of books and time and labor.

A formal vote of thanks will be passed at the next meeting of our members, and a copy will be sent you.

Cordially yours,
(Signed) Leverett Mills Loomis,
Director of the Museum.

The New York *Evening Post* says: "The poorly paid college professor has even his financial compensations. No one has more brilliant opportunities to get rich without effort than he. During the present fall he has been kindly offered at least half-a-dozen different positions on the ground floor of a western marble quarry containing nearly a billion feet of marble which is to be taken out and sold at a profit of nearly two billions of dollars, as soon as a little necessary machinery is secured by the sale of a few bonds at about par, with something like an equivalent amount of stock thrown in. When one considers that this investment is to pay 100 per cent. profit annually as soon as it gets its machinery well oiled, it is evident that, as a benefactor to indigent college professors, Carnegie has been easily distanced. For such as have any moral objections to profits of that size, the same company has an alternative in an Ohio coal proposition which is practically certain not to net more than 50 per cent. clear annual gain." The above scheme is prominently supported by the name of a professor in an American university. If this is done without his knowledge, he should take early

opportunity to see that his name is not further used in this way.

WE learn from the *Electrical World* that at the opening of the regular monthly meeting of the American Institute of Electrical Engineers, held November 23, Secretary Ralph W. Pope announced that on the evening before upon the invitation of the trustees of the United Engineering Society, the boards of directors of the three founder societies inspected the new building. The office floors are practically complete and ready for occupancy; the auditorium and grand entrance hall on the first floor are yet in the hands of the contractors. All were impressed with the stately character of the building, and all felt satisfaction with the way the architects have carried out the great work. There was an informal dinner at half-past six, and although the meeting was of an informal character, resolutions were passed authorizing the trustees of the United Engineering Society to proceed with arrangements for the formal dedication of the building in April next. The societies will, however, occupy their suites in the building in the course of a month or two. At this informal gathering Chairman Thomas Commerford Martin, of the Building Fund Committee, announced that Mr. George Westinghouse, for himself and as representing the various Westinghouse Companies, had contributed to the land, building and endowment fund the sum of $50,000, to be equally divided between the three founder societies toward the payment for the land. This was followed by the announcement that the Allis-Chalmers Company had contributed the sum of $3,500, to be similarly divided between the three societies. This brings the amount pledged toward the payment of the A. I. E. E. proportion of the land to $155,000, out of $180,000, which is the sum total. Chairman Martin assured the gentlemen present that he felt that when the building was formally dedicated, so far as the American Institute of Electrical Engineers was concerned, it would assume its responsibility, one-third of the land, free from debt. Mr. Pope said that from his knowledge of the situation he feels quite assured that this will be the case, and that the American Institute of Electrical Engineers, which twenty years ago was following the trail of the other engineering societies, will assume its responsibilities free from debt and with an income that will assure the handling its part of the building for all time to come, with the generous support of the members of the institute. The building is admirably calculated to accommodate meetings of various societies, from an audience of 1,000 down to 150, and the accommodations are such that all will feel well satisfied personally with the situation, when they come to meet in the building and inspect the offices and the general quarters, the library and all the accessories.

WE learn from the *London Times* that the departmental committee which was recently appointed to "inquire and report what diseases and injuries, other than injuries by accident, are due to industrial occupations, are distinguishable as such, and can properly be added to the diseases enumerated in the third schedule of the workmen's compensation bill, 1906," has now begun its inquiry. The committee proposes to investigate the following diseases and injuries which have been suggested for its consideration, viz., gradual poisoning from the vapor of carbon disulphide, dinitrobenzol, dinitrotoluol and anilin; gradual poisoning from carbonic oxide gas, sulphuretted hydrogen gas, and chlorine gas; alkaloidal poisoning from African boxwood in shuttlemaking; illness set up by nitrous fumes, hydrochloric acid fumes, ammonium chloride fumes and sulphur fumes; compressed air illness (caisson disease); chrome ulceration of the skin; various trade eczemas; fibrosis of the lungs from inhalation of silicious or metallic particles (potter's asthma and grinder's phthisis); pneumonia from inhalation of basic slag dust; miner's nystagmus and miner's 'beat knee' and 'beat hand'; neurosis due to vibration; cardiac dilatation in slate quarries; and glanders. Correspondence relating to the inquiry should be addressed to Frank Elliott, Esq., secretary to the committee at the Home Office, Whitehall, S. W. Anthrax, ankylostomiasis and poisoning by lead, mercury, phosphorus and arsenic

are already included in the third schedule of the workmen's compensation bill, and are not, therefore, within the committee's terms of reference.

PROFESSOR C. H. JUDD, of Yale University, gave an address on 'Visual Perception' before the Washington Academy of Sciences on November 27. The address was illustrated by lantern slides, showing the method of photographing the eyes and giving the results of the study of eye movements. It was discussed by Professor George M. Stratton, of Johns Hopkins University.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. WILLIAM SMITH, of Geneva, has given $500,000 to Hobart College to endow a college for women.

IT is announced that Mr. Andrew Carnegie has offered to give $100,000 to Queen's University, Ontario, on condition that the additional sum of $400,000 be collected.

THE trustees of the late Mr. T. Graham Young have presented to the governors of the Glasgow and West of Scotland Technical College a sum of £10,000 to assist in making provision for the teaching of dyeing and bleaching in connection with the chair of technical chemistry in the college. Mr. Young's trustees have also voted a sum of £850 for the equipment of the laboratory.

THE majority of the committee of alumni of the Andover Theological Seminary has handed in a report adverse to the removal of the seminary to Cambridge and its affiliation with Harvard University.

IT is reported that the University of Warsaw will be removed to Saratoff and the Warsaw Polytechnic School to Rostoff-on-the-Don. This would leave Russian Poland without a university.

ASSISTANT PROFESSOR ALEXANDER W. EVANS has been promoted to fill the Eaton professorship of botany in the Sheffield Scientific School of Yale University.

DR. S. M. LINDSAY, professor of sociology in the University of Pennsylvania, has been called to a newly-established chair of social legislation at Columbia University.

JOHN L. STEWART, professor of economics and history at Lehigh University, has been appointed director of the library of that institution to succeed the late Professor William H. Chandler.

THE registration of the University of Maine for the present year shows an attendance of 56 in the College of Agriculture, and 391 in the College of Technology, with 29 in the faculty of the former college and 35 in the faculty of the latter. The new members of the faculty and changes in the various scientific departments follow:

W. M. Munson, Pomologist in the Experiment Station.

W. D. Hurd, Acting Dean of the College of Agriculture.

A. C. Jewett, and W. K. Ganong, promoted to professorships in Mechanical and Electrical Engineering.

W. J. Morse, Vegetable Pathologist in the Experiment Station.

A. W. Gilbert, promoted to Assistant Professor of Agronomy.

P. A. Campbell, Instructor in Animal Industry.

R. W. Seabury, Instructor in Biological and Agricultural Chemistry.

C. B. Brown, Instructor in Civil Engineering.

E. E. Moots, Instructor in Mathematics.

H. A. Emery, Instructor in Civil Engineering.

M. J. Dorsey, Instructor in Horticulture.

C. J. Carter, Instructor in Machine Work.

G. F. Wittig, Instructor in Electrical Engineering.

A. C. Whittier, Assistant Chemist in the Experiment Station.

J. C. Colcord, Assistant Chemist in the Experiment Station.

F. Balentine, Tutor in Biology.

H. W. Bearce, Tutor in Physics.

MR. R. P. GREGORY, of St. John's College, has been appointed senior demonstrator in botany in Cambridge University.

AT Cambridge University the Cavendish professor of experimental physics and the Lucasian professor of mathematics have appointed Mr. F. Horton, fellow of St. John's College, to be Clerk Maxwell student in succession to Mr. O. W. Richardson, of Trinity College.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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UNIVERSITY REGISTRATION STATISTICS.

THE statistics given on page 798 are, with few exceptions, approximately as of November 1, 1906, and relate to the registration at twenty-three of the leading universities throughout the country. Two new institutions have been added to the list, the University of Kansas and New York University. The figures have in every case been secured from the proper officials of the university concerned; wherever detailed information has been furnished with reference to causes of increase or decrease in registration, changes in equipment, etc., the material is set off by smaller type. At the majority of institutions, additional registrations during the remainder of the academic year will increase somewhat the figures given in the table. This is especially true in the case of an institution like Columbia, which admits new students to its academic department in February, as well as in September.

Comparing the figures for 1906 with those for 1905, it will be seen that a number of institutions show a loss, which, in the case of California (−10.61%) and Leland Stanford (−4.73%), may be traced to external causes. The other universities that have suffered a decrease in attendance are Johns Hopkins (−10.17%), Northwestern (−5.59%) and Columbia (−2.21%). The greatest gains have been made by Pennsylvania (14.69%), New York University[1] (12.74+%), Indiana

[1] The Kansas and New York University figures for 1902 to 1905, and the Nebraska figures for

(10.02%), Missouri (9.75%), Syracuse (8.21%), Virginia (7.04%), Nebraska (6.52%), Ohio (5.98%), Cornell (5.27%), Illinois (4.81%), Chicago (3.59%) and Michigan (3.38%). Harvard (1.14%) and Wisconsin (0.52%) show slight gains, while the registration at Kansas,[1] Minnesota, Princeton and Yale has, to all intents and purposes, remained stationary.

If we compare the registration of 1906 with that of 1902, we shall find that every university, with five exceptions, has increased its registration during the intervening period, the exceptions being California (−11.71%), Northwestern (−8.35%), Indiana (−8.07%), Johns Hopkins (−7.62%) and Harvard (−2.29%). The largest gains during this period have been made by Pennsylvania (54.34%), New York University (49.16+%), Missouri (47.09%), Ohio State (36%), Kansas (30.60+%) and Virginia (27.13%). Next come Cornell (24.20%), Michigan (24.18%) and Yale (24%), and these are followed by Minnesota (12.52%), Stanford (11.03%), Chicago (10.13%), Nebraska (9.65+%), Columbia (8.09%) and Wisconsin (7.46%). The enrollment at Princeton has remained stationary, the increase being one of only 0.52%. In the case of several institutions the large gains may be ascribed to the establishment of summer sessions.

According to the figures for 1905, the twenty-one universities included in the table ranked as follows: Harvard, Columbia, Chicago, Michigan, Minnesota, Cornell, Illinois, California, Yale, Pennsylvania, Wisconsin, Northwestern, Syracuse, Nebraska, Ohio State, Missouri, Leland Stanford, Indiana, Princeton, Virginia and Johns Hopkins. Comparing this with the order for 1906, we notice that for reasons to be discussed more in detail later, several changes have occurred. Harvard still has the largest registration, but is followed by Chicago, with Michigan third and Columbia fourth. Cornell has this year a larger registration than Minnesota, Pennsylvania and Yale have passed California, and the former has made other gains, the order this year—after Cornell—being Minnesota, Pennsylvania, Illinois, Yale, New York University, California, Wisconsin, Syracuse, Nebraska, Northwestern, Ohio State, Missouri, Kansas, Indiana, Princeton, Virginia and Johns Hopkins. Omitting the summer session registration, the order would be as follows: Harvard, Michigan, Columbia, Chicago, Pennsylvania, Cornell, Minnesota, Illinois, Yale, New York University, Syracuse, California, Wisconsin, Nebraska, Northwestern, Chicago, Ohio State, Missouri, Kansas, Stanford, Princeton, Indiana, Virginia and Johns Hopkins.

I desire at this place to express the hope that this article will not be interpreted by the reader as desiring in any way to place undue emphasis upon mere numbers as the most important factor in the development of a higher institution of learning; at the same time it will no doubt be of interest to notice where and how gains and losses have been experienced. No sensible person will regard the number of students in attendance at a university as the sole criterion of the advantages that one institution has over another.

Examining the different faculties, we notice that most of the institutions this year show an increase in enrollment in the academic department. This is true as far as men are concerned of every institution in the table, with the exception of Johns Hopkins and Wisconsin, and it is a rather remarkable fact, since several universities for a number of years have registered continual losses in their academic departments —these losses being in many cases due to corresponding gains in the scientific schools. A reaction has apparently set in in this direction, at least at a number of institu-

1902, are those for the close of the respective academic years.

tions. At Princeton, for example, the number of academic students has increased from 629 to 758, at Yale from 1,323 to 1,350, at Columbia from 557 to 606; whereas the number of scientific students at the same institutions has decreased from 624 to 484 in the case of Princeton, from 1,028 to 929 in the case of Yale and from 566 to 524 in the case of Columbia. At Harvard the discrepancy is even greater, the reason for which will be given later. The only other institution, in addition to those mentioned above, which shows a loss in the enrollment of the scientific schools is the University of California, and there the decrease is scarcely worthy of mention. The largest gain in the number of scientific students has been made by Illinois (from 880 to 1,020). As far as the number of women in academic courses is concerned, there has been a decrease at California and Stanford, while in all of the other institutions there has been a noticeable gain, particularly at Indiana, where the number has increased from 299 to 397; at Missouri, where a gain from 281 to 354 may be noted, and at Wisconsin, where the number of women has grown from 653 to 718.

The professional schools of law and medicine show a general falling off in attendance, appreciable gains in law having been made only by Chicago, Illinois, Indiana, Missouri, Northwestern, Syracuse, Virginia and Yale; and in medicine only by Indiana, Northwestern, Pennsylvania, Virginia and Yale. Strange to say, a number of the institutions show a decrease also in the enrollment in the graduate schools, appreciable gains having been registered only in the case of Cornell, Missouri, Virginia and Wisconsin. In pharmacy some of the institutions have made slight gains, while others show a loss. None of the institutions has lost veterinary students and the same holds true for forestry, although the gains are in no case large. The only dental schools that show an increase are those of Michigan and Pennsylvania. Architecture and music exhibit gains all along the line, with few exceptions. Minnesota and Ohio are the only institutions which have experienced a loss in students of agriculture. The divinity school at Harvard is practically as large as it was last year, while at Northwestern there is a loss of forty-six, at Yale of six and at Chicago of four students. Pedagogy shows a healthy increase in all but one of the institutions (Wisconsin).

Harvard still maintains the large lead that it has had for a number of years in the academic department. Inasmuch as a number of universities do not separate men from women in the academic statistics, it is difficult to determine the exact order for men only, but taking both men and women into consideration, the order would be Harvard, Michigan, Wisconsin, California, Leland Stanford, Minnesota, Yale, Chicago, Syracuse, Columbia. It will thus be seen that of the ten universities having an enrollment of over one thousand academic students, six are situated in the west. Cornell still leads in the number of scientific students, Michigan occupying second place, as was the case last year. Illinois comes third, followed by Yale, Wisconsin, Ohio State, California, Pennsylvania, Nebraska, Minnesota, Missouri and Columbia. Of the twelve institutions in the table with an enrollment of over five hundred scientific students, eight are located in the western states. New York University has the largest law school among the institutions in the list, with Michigan second, Harvard third and Minnesota fourth, Harvard being the only one of these four requiring a baccalaureate degree for admission. Pennsylvania has the largest medical school, with Northwestern second and Illinois third. As for the graduate schools, Columbia with an enrollment of 808 students

is by far the largest, Harvard with 437, Chicago with 358 and Yale with 357 following in the order named. Minnesota has by far the largest school of agriculture, while Pennsylvania leads in the students of architecture and Syracuse in those of art; Pennsylvania also has by far the largest school of dentistry, Northwestern leads in divinity and Yale in forestry (although some of the western institutions that include forestry under agriculture may actually have more forestry students than Yale); Syracuse has the largest school of music, Columbia the largest teachers' college, as well as the largest school of pharmacy, Ohio State the largest number of veterinary students. As far as the summer session of 1906 is concerned, Harvard and Columbia attracted more than one thousand students, Michigan, California, Indiana and Cornell following in the order named.

Taking up the different institutions included in the table in alphabetical order, we come first to the *University of California.*

The total number of undergraduates in the colleges of letters and science (including engineering) is 2,365, a gain of just three as compared with November 1, 1905. This is the largest number of undergraduates ever enrolled at this period of the academic year. The number of graduate students is 204, a loss of 67. This loss, however, is more apparent than real. Last year there was an unprecedented increase in the enrollment of graduate students, due to a new regulation which made it necessary for the graduates of 1905 who were applicants for the teachers' certificate to return to the University for at least a half-year of graduate study. For various reasons due to local conditions, this regulation was temporarily suspended for the class graduating in the summer of 1906. As a result very few of the graduates of last summer who were aiming at teachers' certificates have found it necessary to come back to the University for work in the graduate department. Hereafter, by action of the State board of education, high school teachers in California are not to be certificated on University credentials without a year of professional study following the baccalaureate degree.

Turning now to the professional colleges, in San Francisco, it will be noticed that the school of art has been temporarily discontinued. The building and the equipment of the school were totally destroyed by fire, though a few of the most valuable paintings in the gallery were rescued. As regards the loss of students in the other professional colleges, it is to be said that existing conditions in San Francisco are only in part responsible. Some of these colleges have been losing heavily during recent years and others have been barely holding their own. As was reported a year ago, the college of medicine has revised its admission requirements and demands, in addition to the equivalent of a four years' high school course, at least two years of properly selected university work. Eight or ten years ago the colleges of law, dentistry and pharmacy began to decline in number of students. During the last four years the enrollments of law and pharmacy have been practically stationary, and that in dentistry has continued to decline.

The principal additions to our equipment during 1905–6 were as follows: California Hall was completed and occupied. The administrative offices and the departments of history, economics, political science and education as well as the Bancroft library are housed in this building. The cost of the building, including equipment, was $292,000. In the men's gymnasium, new dressing rooms and showers were added at a cost of $30,000. In the women's gymnasium similar improvements were installed at a cost of $8,100. Temporary accommodations were provided for the departments of architecture and entomology at a combined cost of about $7,000. The university has established on the campus a students' infirmary. For the present, a wooden building upon the campus, formerly used as a dwelling-house, will be refitted and equipped as an infirmary and dispensary. For the maintenance of the infirmary the students here at Berkeley (colleges of letters and science, including engineering) are assessed two dollars and a half per half-year.

I have recently taken some pains to investigate the precise result of the San Francisco disaster upon the living accommodations of the students. It will help in understanding the questions at issue if the reader be reminded that the University of California has never maintained dormitories for the students; and that in 1894–95 only 51% of the students attending the colleges at Berkeley had their lodgings in Berkeley dur-

ing the university sessions. The remainder of the students found their lodgings in Oakland, San Francisco, and other nearby cities and towns. During the past twelve years the proportion of students lodging in Berkeley has increased steadily. In 1905–6, 78.6% of the undergraduate students and 75.4% of the graduate students had their lodgings in the University town. This great increase took place in spite of the fact that during these twelve years there were remarkable improvements in the means of interurban transportation in this vicinity. One might have supposed that this increased convenience in transportation would have induced a relatively larger number of students to live in Oakland or San Francisco or Alameda. Happily for the solidarity of university life and spirit, no such result has come about.

During the weeks following the earthquake and fire in April last, many thousands of people from San Francisco made their homes in the suburban towns, including Berkeley. For a time it seemed as if the students of the summer session would not be able to find lodgings in Berkeley. Even more strongly it was feared that accommodations for the 2,500 or more students who were to be registered during the regular session beginning in August, would be far from adequate. There were not wanting prophets who declared that it would be necessary for the students to live in tents or portable houses or to find rooms in Oakland or in settlements miles from the university. It is found, however, that the number of undergraduate students who have taken lodgings here in Berkeley this year is two per cent. greater than one year ago. As for the graduate students, the relative increase in Berkeley residents is 5.1%.

For the student who finds it necessary to economize, the cost of comfortable board and lodging in Berkeley is estimated to have increased not to exceed 10%, which increase is doubtless a temporary condition following the influx of San Francisco residents in and after April last. In many of the students' clubs and fraternities there has been no increase at all in living expenses.

Perhaps the most distinctive new feature of our university life during the past year has been the series of university symphony concerts, given in the Greek theater under the direction of Professor J. Frederick Wolle, who began his work in the university as professor of music in September, 1905. The first series of symphony concerts was begun in February and continued until May. The maximum attendance at any one performance reached 7,000 and at no time fell below 4,000. A second series is now being given and will be continued until late in November.

One of the most notable acquisitions of the past year is the Bancroft historical library of 50,000 volumes and 125,000 manuscripts, which has recently become the property of the university. Following the installation of this library, there has been established an academy of Pacific Coast history.

As for the *University of Chicago*, attention has been called to the fact that it is very difficult to compare the enrollment at Chicago with that of other institutions, on account of the four-quarter system in vogue at the former institution, during each or all of which a student may be in residence. To quote from the *Boston Evening Transcript* of October 20:

To enable an exact comparison of student attendance with that of other institutions having the customary three-quarter (equal to nine months) system, the attendance of students is usually reduced to the three-quarter system. A student in residence one-quarter equals one-third of a unit; in residence two-quarters equals two-thirds of a unit; in residence three-quarters equals one unit; and in residence four-quarters equals four-thirds of a unit. On this three-quarter basis the total enrollment for 1905–6 would be 3,205. The attendance during the summer quarter of 1906 was the largest in the history of Chicago summer quarters. The total registration for the first term of the summer of 1906 was 2,385, as against 1,999 in 1905, showing a gain of 19.3%. The attendance the second term was 1,583, as against 1,347 last year, a gain of 17.5%. The total number of different students for the entire summer of 1906 is 2,702; the total number of different students in both terms in 1905 was 2,293, showing a gain of 17.8%. Gains were distributed rather uniformly through the different schools and colleges, the largest percentage of gain, however, being in the divinity school; the college of education also showed a large increase in attendance. Of the total number of students in the different schools, 2,702, it may be added that 1,308 were men and 1,394 were women.

An inspection of the accompanying table will show that there has been a slight decrease in the total registration of *Columbia*

COMPARATIVE REGISTRATION FIGURES, NOVEMBER, 1906

Faculties	California	Chicago	Columbia	Cornell	Harvard	Illinois	Indiana	Johns Hopkins	Kansas	Leland Stanford, Jr.	Michigan	Minnesota	Missouri	Nebraska	New York	Northwestern	Ohio State	Pennsylvania	Princeton	Syracuse	Virginia	Wisconsin	Yale
College Arts, Men	566	702	606	} 731	2236	362	503	166	352	993	} 1528	515	371	290	263	368	268	307	755	} 1332	278	785	1350
College Arts, Women	929	647	398		399	395	397	—	364	476		871	354	669	152	479	266	—	—		—	718	—
Scientific Schools*	758	—	524	1544	242	1020	—	—	400	—	1197	615	577	619	194	—	770	636	484	407	118	782	929
Law	40	146	261	206	689	156	189	—	170	140	748	441	232	171	806	235	149	297	—	180	206	150	290
Medicine	54	145	352	336	296	488	65	264	107	—	423	196	65	132	448	500	—	594	—	150	133	—	155
Graduate Schools	204	358	806	212	437	139	—	156	50	49	96	53	107	95	222	40	41	285	110	65	43	302	357
Agriculture	112	—	—	256	43	361	—	—	—	—	—	763	108	175	—	—	180	—	—	—	—	143	—
Architecture	†	—	87	83	‖	130	—	—	—	—	—	—	—	—	—	—	17	136	—	45	—	—	—
Art	‡	—	—	—	‖	13	—	—	16	—	—	—	—	59	—	—	—	—	—	77	—	—	40
Dentistry	35	—	—	—	65	85	—	—	—	—	168	162	—	—	—	325	—	356	—	—	—	—	—
Divinity	—	173	—	—	37	—	—	—	—	—	—	—	—	—	—	210	—	—	—	—	—	—	82
Forestry	**	—	—	—	‖	**	—	—	—	—	—	**	—	—	—	—	12	—	—	—	—	—	59
Music	†	—	26	—	‖	104	—	—	127	—	—	†	—	315	—	367	—	44	—	619	—	230	81
Pedagogy	†	178	726	—	‖	†	—	—	—	—	—	†	277	—	420	—	—	—	—	332	—	58	—
Pharmacy	45	—	254	—	—	171	—	—	80	—	92	71	—	—	—	120	66	—	—	—	—	34	—
Veterinary	—	—	—	88	—	**	—	—	—	—	—	—	—	—	36	—	125	111	—	—	—	—	—
Other Courses	—	247	—	248	—	42	—	32	—	—	—	—	—	200	544	131	62	1028	—	40	—	—	—
Deduct Double Registration.	—	(167)	(156)	(5)	(15)	—	(106)	—	(139)	(140)	(81)	—	(288)	(70)	(61)	(140)	(2)	—	—	(328)	(33)	(483)	(71)
Total	2743	2429	3886	3699	4429	3466	1048	618	1527	1518	4171	3687	1808	2655	3024	2635	1954	3794	1352	2919	745	2719	3272
Summer Session, 1906	707	2702	1041	642	1074	502	682	—	265	51	794	336	403	246	351	—	389	275	—	131	—	550	222
Deduct Double Registration.	(204)	(400)	(277)	(266)	(160)	(158)	(215)	—	(102)	(39)	(291)	(79)	(135)	(94)	(92)	(—)	(163)	(135)	—	(46)	—	(170)	(17)
Grand total, 1906	3246	4731	4630	4075	5343	3810	1515	618	1690	1530	4674	3944	2071	2807	3283	2635	2180	3934	1352	3004	745	3099	3477
" " 1905	3631	4557	4755	3871	5283	3635	1377	688	1706	1606	4521	3940	1887	2635	2912	2791	2057	3430	1361	2776	696	3083	3477
" " 1904	3738	4085	4833	3833	5392	3369	1206	740	1446	1424	4000	3886	1704	2728	2380	2856	1758	3027	1385	2452	691	3370	3008
" " 1903	3690	4146	4557	3438	6013	3239	1614	694	1319	1370	3926	3550	1540	2513	2177	2740	1710	2644	1434	2207	638	3221	2990
" " 1902	3676	4296	4302	3281	5468	—	1648	669	1294	1378	3764	3505	1408	2560	2201	2875	1603	2549	1345	2020	586	2884	2804
Officers	336	341	600	525	583	424	85	189	109	150	332	324	164	175	262	290	176	375	177	213	83	313	428

*Includes schools of chemistry, engineering, mining and related departments.

†Included in college statistics. ‡Temporarily discontinued.

‖Not a separate school; courses taken by undergraduate and graduate students in college or scientific school and graduate school respectively.

**Included in agriculture.

University in comparison with last year, the decrease being due primarily to losses in several of the professional faculties. Columbia College shows a considerable increase over last year, the registration in this faculty having reached the high-water mark. There will no doubt be forty or fifty new students in February, which would bring the total registration at the close of the year to about 650, as against 589 for 1905–6. The entering class in the College is the largest in its history. Barnard College continues to show an increase and the figures will probably pass the 400 mark before the close of the year. The graduate faculties of political science, philosophy and pure science all have practically as many students as they had last year. This year for the first time the period of registration was reduced considerably, and as a result a number of students who did not report at the university in time failed to register altogether. The faculty of applied science again shows a decrease over the preceding year, although the number of new students is equal to that of last year. The requirements for advancement in this faculty have been increased considerably, and as a result a number of students who were unable to maintain their standing found it desirable to leave the institution. There has, accordingly, been a considerable improvement in the quality of the material, from the standpoint of scholarship. Under the faculty of fine arts, the school of architecture shows a decrease, due to the increased requirements for entrance—two years of college preparation—to the course leading to the degree. The law school shows a slight falling off this year, although the entering class is much larger than that of 1905. To the 92 students in the first-year class should be added 22 men from Columbia College enrolled also under the law faculty. The requirements for advancement in the law school have been strengthened considerably, and this accounts to a certain extent for the decrease in the second-year and third-year classes. All four classes of the medical school are classes that entered under the increased requirements, whereas last year there were only three such classes. The probabilities are, therefore, that the attendance at the medical school has reached its minimum this year, and from 1907 on there should be a gradual increase in the size of the entering class. Conditions at the College of Pharmacy are similar to those in the medical school, inasmuch as both of the present classes entered under the increased admission requirements, whereas last year one large class which had entered the year before the strengthened requirements became operative still remained. The increase in the number of graduate students at the College of Pharmacy is very encouraging. In spite of the fact that the first-year class at Teachers College has been abolished, this school shows an increase in primary registration of fifty-one over last year. In 1905 and the years preceding, Columbia and Barnard students who were also candidates for a diploma in teaching were included under Teachers College, but if the primary registration only is counted, it would show an increase from 667 in 1905 to 718 in 1906.

In connection with the development of material equipment, attention may be called to the fact that the Chapel and Hamilton Hall (a half-million-dollar building for the use of the undergraduate college for men) are ready for occupancy and that the corner-stone of Brooks Hall, a dormitory for Barnard College—the undergraduate department for women—has been laid. Among other important developments may be mentioned the establishment of a faculty of fine arts, comprising schools of architecture, design and music, the courses in design to be conducted in

cooperation with the National Academy of Design. In connection with the faculty of fine arts a course of study is offered for the first time leading to the degree of bachelor of music, and several students have become enrolled as candidates for this new degree. The Theodore Roosevelt professorship of American history and institutions in the University of Berlin and the Kaiser-Wilhelm professorship of German history and institutions at Columbia University were founded during the past year, Professor John W. Burgess, dean of the faculty of political science, being the first incumbent of the chair at Berlin, and Hermann Schumacher, of the University of Bonn, being the first incumbent of the Columbia chair. President Arthur T. Hadley, of Yale, has been appointed second Theodore Roosevelt professor. Columbia and Yale have cooperated in the establishment of courses in preparation for foreign service, and several Columbia students have become candidates this year for the consular certificate. The joint course of study is intended for the benefit of young men preparing for work in foreign countries, whether in the service of the United States government, in business enterprises, or as missionaries or scientific investigators. Barnard College has established a course leading to the degree of bachelor of science. The work of the first two years of the collegiate course of Teachers College will be transferred from Teachers College to Columbia College, for men, and to Barnard College, for women. In other words, a candidate for the B.S. degree in education spends the first two years at Columbia or Barnard College, respectively, and the last two years at Teachers College. In accordance with this arrangement the first-year class at Teachers College has been abolished this year; the second-year class will fall out in 1907.

At *Cornell University* there has been a noticeable gain in the academic department, as well as in the scientific schools. Under 'scientific schools' are included only those of mechanical engineering (with an enrollment of 1,084 students) and civil engineering (with an enrollment of 460 students), the students in chemistry being included under the academic department, and not under the scientific department. Practically all of the gain in the scientific schools has been made in the department of civil engineering, the enrollment of Sibley College (the department of mechanical engineering) having remained stationary. The schools of law and medicine show a decrease, the graduate schools and the school of agriculture an increase, while the school of architecture and the veterinary college have practically the same enrollment as in 1905. The summer session shows a gain from 619 to 642, although the number of summer-session students who returned for work in the fall has decreased from 312 to 266.

The total attendance at *Harvard University* shows an increase, to which the academic department particularly has contributed. The law school and the graduate schools, as well as the school of dentistry, show a falling off, while divinity has the same enrollment as last year. Medicine shows an increase of six.

The increase in Harvard College (from 1,898 to 2,236) and the noticeable reduction of the Lawrence Scientific School (from 507 to 242) is due to changes of classification and also to new plans of study adopted by scientific undergraduates in connection with the establishment this year of the new graduate school of applied science. This year students formerly registered in the Lawrence scientific school were given their choice of remaining in the four-years prescribed programs leading to the degree of B.S. in a designated field of study, such as mining engineering or architecture, or of shifting their registration to Harvard College, there to receive the plain degree of B.S. on an elective course of study. Those who have chosen the latter alternative will in many cases take a more liberal course of study than would have been open to them in the Law-

rence scientific school, postponing their advanced professional work until they enter the graduate school of applied science, where they will spend two or three years. Owing to these changes, the body of students corresponding to that which has heretofore been catalogued as scientific, that is, in the sense that they are actually working toward a professional degree in science, can only be found by adding to the students in the old undergraduate four-year programs in science, all those students now in Harvard College who, while candidates for the elective B.S. or the A.B., are continually pursuing such elementary or introductory studies in science as shall most effectively advance their subsequent candidacy for one of the degrees of the graduate school of applied science.

To extricate these undergraduates so as to furnish a satisfactory comparison with last year is so complicated and futile a task, that it seems best to let the category 'scientific schools' stand with its apparently heavy loss. It may be predicted that the undergraduate portion of this category (212 in 1906) will disappear in a few years, while the graduate portion (30 in 1906) will slowly increase, until the scientific professional branches are completely established at Harvard on the graduate level on which its schools of divinity, law and medicine already stand.

As among the most important events of this period at Harvard should be mentioned the establishment of the medical school in its five great white marble buildings on land already arranged for the neighboring occupancy of a group of important hospitals—an equipment which is noteworthy not only for its present adaptation to medical instruction and research, but also for its generous and minutely elaborated allowances for future growth. The other important addition to Harvard's equipment of buildings is the new building for the law school, to be called Langdell Hall, in honor of the late dean of the school.

In the financial administration of the University an important feature this year is the establishment in the departments within the faculty of art and sciences of a new system of tuition fees, whereby each student is obliged to pay in addition to the lump sum of one hundred and fifty dollars a year, twenty dollars for each course beyond the minimum number required for a full year's work.

Harvard is offering this year for the first time a considerable group of afternoon and Saturday courses for teachers. The students thus enrolled are not counted in the table.

At the *University of Illinois* there has again been a good increase in the grand total, but the increase aside from the summer session is also quite marked. Gains have been made in every department, with the exception of medicine, dentistry and the graduate schools, the largest increase having been made (as was the case last year) by the scientific schools. The 42 students mentioned under 'other courses' are enrolled in the library school, which offers a five-year course leading to the degree of B.L.S.

The enrollment in *Indiana University* shows a satisfactory increase all along the line, the growth being noticeable especially in the academic department for women, where the enrollment has increased from 299 to 397, and in the school of medicine, which has increased from 26 to 65 students.

At *Johns Hopkins University* there has been a decrease in enrollment, the college registration having dropped from 188 to 166, that in medicine from 293 to 264, that in the graduate schools from 160 to 156, and in 'special courses for physicians' from 47 to 32.

As the figures of the *University of Kansas* for 1902 to 1905 are those for the close of the respective academic years, no accurate comparisons can be made. No doubt the final figures for 1906–7 will show a gain over last year. The large increase in 1905 was due to the merging of the university medical school and three medical schools in Kansas City, Mo. This university is at present erecting a $100,000 gymnasium, which is to be occupied in the fall of 1907.

Leland Stanford University shows a slight decrease, the reason for which is self-evident. This decrease has made itself felt in all departments but law, which has remained stationary. It should be noted in connection with the statistics of this university that the number of women is lim-

ited to 500, and that in future the number of men also will be strictly limited, probably on the following basis; about 500 in the general courses, 500 in the engineering and law courses and an unlimited number of graduate students.

The University of Michigan shows no such remarkable gains in attendance as was perceived last year at the same date; nevertheless, there has been a considerable increase everywhere except in the departments of law and homeopathic medicine, and in the graduate schools. The decrease in the professional schools mentioned may be due partly to the increased requirements for admission. While the number of women remains approximately the same, the number enrolled as first-year students is smaller and those coming with advanced credits from other colleges correspondingly larger. The attendance of women by departments is as follows: academic 655, medicine 22, homeopathic medicine 10, dentistry 5, pharmacy 2, engineering 1, graduate schools 25. The inability to secure absolutely accurate returns from the University of Michigan has somewhat marred the value of the figures from this institution.

The *University of Minnesota* shows a slight loss over last year in the fall registration, although an increase in the enrollment of the summer school brings the grand total four in advance of last year's figures.

The total of 3,944 does not show the complete registration for the year, as the law school is conducted on a term system, and students will enter late for work of the different terms. Also at the beginning of the second semester we shall have from fifty to one hundred students entering the various departments. The graduate registration will also be increased somewhat before the year is over. The other departments will remain almost exactly as stated. A conservative estimate therefore of the total enrollment for the current year will be something over 4,000, between 4,000 and 4,100. A comparison of the statistics of this year with those of last shows a slight increase in nearly all departments except the graduate school. The decrease there is due undoubtedly to the establishment of a graduate school with a dean at its head and a regular system of fees, and more rigid requirements regarding the registration of graduate students. The matter of conducting graduate work has been definitely systematized and the fees increased from $10 a year to $10 a semester. This will explain in part the difference in the two registrations. A falling off in the scientific schools, due to the increased standard for admission to the engineering college, was expected, but did not take place. On the contrary, there was an increase from 576 to 615. Entrance examinations are required for one year of elementary algebra, one half-year of higher algebra, one year of plain geometry and one half-year of solid geometry of all students entering this college, regardless of the standard of the schools from which they come. The college of medicine and surgery has increased its entrance requirements from one year to two years. This new requirement is to go into effect in 1907–8. A college of education has just been established with a dean at its head, but because of the newness of the organization, students are classed this year with the college of science, literature and the arts. A slight decrease is expected in the college of dentistry due to the increase in annual fees from $100 to $150. The college has all the students it can take care of and no more would be admitted.

There is a slight decrease in the number of women in the college of science, literature and the arts, and quite a large increase in the number of men. This is explained in two ways. First, the rigid requirements in mathematics have turned some away from the college of engineering and they perforce enter the college of arts, where the bars are not so high. Secondly, the college of science, literature and the arts has made a slight change in the entrance requirements, which really lowers its standard for admission. Heretofore students were required to present a certificate of graduation from an accredited high school and in addition were held for fifteen year-credits. As the choice of these fifteen year-credits was somewhat limited, it was found that students taking the manual training and commercial courses in the high schools had not the proper credits for admission to the college of science, literature

and the arts, whereas those taking the general, scientific, or Latin courses were admitted without question. As the regulation now stands, students are admitted from any accredited school, provided the certificate of graduation shows the completion of four years of English and two years of mathematics, the other subjects being optional. This would naturally lead to an increase in the number of men in the college of science, literature and the arts.

The attendance at the *University of Missouri* continues to increase, the total gain in the fall registration (exclusive of the summer session) being no less than 178 this year, as against a gain of 89 last year. This gain is distributed over all the departments, with the exception of medicine.

In the department of medicine there has been an increase of two years work in the entrance requirements. For the session of 1905–6, three years of high school work was required. For the present session, students must have completed one year's college work in specified subjects in addition to the four years' high school work required for entrance to the college. This increase in entrance requirements is in large part responsible for the decrease in enrollment in the department of medicine. For the past eighteen months there has been considerable agitation for the removal of the work of the two last years in medicine to St. Louis or Kansas City. While no definite decision has been made, as yet, it is probable that the uncertainty contributed in some measure to the loss in this department.

The large increase in pedagogy is a continuation of the movement which commenced in 1904, as a result of the organization of the teachers college and the strengthening of the instruction in this department.

The increase in the academic department (college of arts) is partly due to the increased tendency of students to take the A.B. degree before beginning professional work. This has been promoted by the establishment of combined six-year courses. The increase in the entrance requirements to the department of medicine, referred to above, has also affected the increase in enrollment in the academic department. The large increase in the number of women in the university, too, has affected the enrollment in the academic department and teachers college. This marked increase commenced in 1903 with the opening of Read Hall, a dormitory for women. Of the 2,071 students, 1,483 are men and 588 are women as compared with 1,388 and 499 respectively, in 1905, at the same date.

The *University of Nebraska* shows an increase in every faculty, with the exception of law, and there has also been an increase in the summer session. The 200 students mentioned under 'other courses' represent the estimated enrollment in the short course in agriculture, which begins on January 2. It is rather difficult to make accurate comparisons for the earlier years, inasmuch as the figures for 1902, 1903 and 1904 represent the final figures for the respective academic years, while the 1905 figure represents the enrollment as of November 1 of that year. No doubt the total enrollment for the academic year 1906–7 will reach 2,900.

As *New York University* was not included in the table last year, no comparisons of individual faculties can be made, but there has been a considerable gain in the total over 1905. Among the changes which may have affected the enrollment should be mentioned the increase in the tuition fee in the schools of applied science from $100 to $125; the increase of the fee in the law school from $100 to $130, and the raising of the requirements for the Ph.D. degree in the graduate school from six to eight courses; the addition of a $5 matriculation fee, and the requirement of a seven-years' degree from graduates of the New York City Normal College. In the veterinary college, the entrance requirements have been raised from thirty-six regents counts to forty-eight.

Northwestern University shows a loss in attendance, which is partly due to the fact that there were no summer-session students in 1906, while there were 194 in 1905, although of the latter 152 returned for work in the fall. The gains in the college and the schools of law, medicine, music and oratory, are not sufficient to offset the losses

in the graduate school and the departments of dentistry, divinity and pharmacy. The students enrolled under 'other courses' are registered in the department of oratory.

Ohio State University shows an increase over last year, the only departments showing a loss being those of agriculture and forestry. Of the 180 students in the school of agriculture, 51 are enrolled in the so-called short course, which is two years in length. Of the 62 students under 'other courses,' 15 are registered in the so-called short course in domestic science, which is also two years in length.

The *University of Pennsylvania* has made considerable gains, especially in the scientific schools, and the schools of medicine, architecture, dentistry and veterinary medicine. The academic department and the graduate schools have remained stationary, while the department of law shows a falling off. The greatest increase is to be found under 'other courses,' namely, one from 621 to 1,028. The students given here are enrolled in the courses in finance and commerce, both day and evening, and in the teachers' courses. Some of the latter no doubt fall in the category of extension students, which are omitted in the case of Harvard, Columbia and other institutions, and should therefore not be included here, but it was impossible to ascertain in time just how many of the students enrolled in the courses for teachers should be omitted. The largest increase was in the summer school, which grew from 214 in 1905 to 275 in 1906. The increase in the Towne scientific school is to be found chiefly in the departments of mechanical and electrical engineering. New requirements have been adopted for admission to the law school which exclude all but college graduates, unless the applicants are more than twenty years old, the law school having heretofore admitted all applicants who passed the college entrance examination, irrespective of age. A splendidly equipped engineering building has been occupied for the first time this fall.

The enrollment at *Princeton University* shows a slight decrease over that of 1905. As has already been pointed out, the academic department shows a gain of over 100, while the scientific schools show a similar decrease, the registration in the graduate schools having remained stationary. The entering class is not as large as it was last year, the loss being attributed to increased requirements and the more rigid enforcement of the same. There has been a marked increase in the number of students entering Princeton on advanced standing from other colleges, although this increase does not quite offset the loss in the entering class.

At *Syracuse University* the only department that shows a decrease is that of art, the schools of medicine, architecture and music, as well as the graduate schools, having remained stationary, while the remaining departments show considerable gains, the academic enrollment having increased from 1,213 to 1,332.

The new buildings at Syracuse University now in process of erection and nearing completion are: (1) The general library, the gift of Mr. Andrew Carnegie, with stack accommodations for three-quarters of a million volumes, a reading room to accommodate three hundred students, and twenty seminar rooms, besides ample accommodations in the first story for the school of library economy. (2) A hall of natural history, erected at a cost of about $200,000. (3) A $100,000 mechanical laboratory for the engineering courses in applied science. (4) A dormitory for men, with capacity for two hundred; cost about $150,000. (5) A chemical laboratory. (6) Fourteen acres of land adjoining the campus and a large structure known for many years as the Castle, the proportions of which are finely adapted to the work of the teachers college have been purchased. (7) A stadium is being built with a seating capacity of about twenty thousand people; it is an excavation and after the Athenian or ancient Syracuse style. The campus of Syracuse to-day comprises ninety-eight acres. The total number of educational buildings is twenty-one.

The *University of Virginia* shows a considerable increase all along the line, and its enrollment this year is the largest in the history of the institution. The department of engineering began with 58 students in the academic year of 1903–4, there were 88 the following year and 118 at the close of the academic year 1905–6. The final registration for this year will no doubt pass 125. Among recent material improvements and additions may be mentioned the repairing and better equipment of the anatomy hall; the provision and equipping of a histological laboratory; further equipment of bacteriological and pathological laboratory; provision and equipment of a laboratory for physiology and physiological chemistry; provision and equipment of an additional chemical laboratory; a residence for the president of the university; the university commons, and a north wing to the hospital.

The *University of Wisconsin* shows a slight decrease in the fall figures, which, however, is more than offset by the increase in the enrollment of the summer session. The chief decrease has been experienced in the number of men in the academic department, all of the other departments, with the exception of pedagogy, showing a gain or having remained stationary. Attention should be called to the fact that graduate students are assigned to the different colleges in which their work principally lies, the total number of graduate students indicated under the caption of 'graduate schools' having been included in the deduction made for double registration. The entrance requirements for admission to the college of engineering were increased this year, more mathematics being demanded than heretofore. No short-course students have been included in the summary. If the students enrolled in the winter course in dairying and in the short course in agriculture were included, it would increase the enrollment at this university considerably.

The fall registration at *Yale University* still continues to increase, although the grand total (on account of a decrease in the number of summer-session students) is exactly the same as it was last year. The departments that show a loss in their registration are those of art, divinity and music, and the graduate schools, although the decrease is in no case large. A striking fact is the slow but regular gain of the academic department during the last five years.

RUDOLF TOMBO, JR.,
Registrar.
COLUMBIA UNIVERSITY.

SCIENTIFIC BOOKS.

An Outline of the Theory of Organic Evolution, with a Description of some of the Phenomena which it explains. Second Edition, revised. By MAYNARD M. METCALF. New York, The Macmillan Company. 1906. 8vo.

Of popular treatises on the doctrine of organic evolution there is a goodly number, but in none is there such clearness in exposition combined with such abundance of well-chosen and well reproduced illustrations as is to be found in Professor Metcalf's volume. This is a sufficient explanation of early appearance of a second edition of the book, which, the author informs us, is 'not intended for biologists, but rather for those who would like a brief introductory outline' of the theory of evolution. To all teachers of biology, however, as well as to the general public, the book will be welcome, especially on account of the numerous excellent figures which serve to illustrate, almost without description, many of the facts upon which the theory is based. Especially valuable is the series of seventeen plates, several of them colored, illustrating variation in domestic animals and cultivated plants, and especial mention may also be made of the beautiful examples of color printing shown in the figures illustrating color in animals. The extent to which the author has relied on illustrations for the exposition of his subject may be gathered from the fact that

no less than one hundred plates and forty-six text-figures accompany the one hundred and ninety-nine pages which compose the text.

The book is divided into two parts, the first of which treats of the theory, briefly discussing inheritance, variation, the struggle for existence, mutation, artificial selection, sexual selection, segregation, and the inheritance of parental modifications. The second part considers the phenomena explained by the theory, under the headings of comparative anatomy, embryology, paleontology, geographical distribution, and the color of animals, and concludes with a chapter on the evolution of man and some general considerations.

Within the brief limits to which the text is confined a consideration of all the factors which have been proposed or recognized as contributing to organic evolution is impossible. The difficulty before the author of such a book is to decide what to omit, and, on the whole, Professor Metcalf may be said to have grappled successfully with his difficulty. But little extra space, however, would have been required for a presentation of the theory of orthogenesis, and a brief account of the observations of Bumpus on sparrows and Weldon on Carcinus would have given a more definite meaning to the term 'selection-value.' Further, it may be remarked, that in the list of works on evolution given in an appendix no mention is made of Haeckel's 'Evolution of Man,' which surely deserves a place in such a list, even if Plate's admirable treatise be excluded, because as yet un-Englished.

These omissions are, however, but minor faults, if faults they may be called. More deserving of criticism is the title of the book, which is really an exposition of the theory of natural selection. In the popular mind the theories of evolution and natural selection are so intimately associated that recent criticisms of the latter and suggestions of various additional factors of evolution have led, in many cases, to the belief that the doctrine of evolution is tottering on its base and is well-nigh, if not entirely, discredited. Nor is the confusion of the two theories altogether confined to the popular mind, and anything which tends to foster it is to be deprecated. Whether natural selection in the Darwinian sense stands or falls, the doctrine of evolution remains unshaken.

And this is not the only confusion that exists with regard to the theory. It has been discussed both as a factor in the origin of species and as a factor in the preservation of species, or rather of adaptations which may or may not be specific. In its former application it is certainly open to criticism; in the latter, and stated as the theory of the elimination of the unfit, it is almost self-evident.

Professor Metcalf's book, unfortunately, tends to perpetuate these confusions; but even with this fault it is a book worth reading and well deserves its success.

J. P. McM.

The Microscopy of Vegetable Foods, with special reference to the detection of adulteration and the diagnosis of mixtures. By Andrew L. Winton, Ph.D., in charge of the Analytical Laboratory of the Connecticut Agricultural Experiment Station, Instructor in Proximate Organic Analysis in the Sheffield Scientific School of Yale University. With the collaboration of Dr. Josef Moeller, Professor of Pharmacology, and Head of the Pharmacological Institute of the University of Graz. With 589 illustrations. New York, John Wiley and Sons; London, Chapman and Hall, Limited.

This work is a very timely one in view of the fact that the pure-food bill will go into effect on January 1, 1907. Owing to the importance of the subject, whether from the point of view of the manufacturer or that of the consumer, it seems rather strange that until now so few good working books have appeared on this subject. While there are several good books by German authors on the subject of the microscopical examination of foods, there is nothing that can compare with the volume at hand.

Both Doctors Winton and Moeller are well known for their valuable researches on the subject of food products. Dr. Winton is a former student of the eminent pharmacognosist, Professor Moeller, and it is rather unique to find a student associated with his

teacher in this way, each contributing his part to a common work, and the whole appearing almost simultaneously in two languages. In the American edition it is Dr. Winton with the collaboration of Professor Moeller, while in the German edition it is Professor Moeller with the collaboration of Dr. Winton. This is a beautiful acknowledgment of their confidence in each other, and we have seldom seen the work of two men that is so much alike in both drawings and descriptions as in this instance.

The work is divided into ten parts, as follows: (1) Equipment, methods and general principles; (2) grain, its products and impurities; (3) oil seeds and oil cakes; (4) legumes; (5) nuts; (6) fruit and fruit products; (7) vegetables; (8) alkaloidal products and their substitutes; (9) spices and condiments; (10) commercial starches. The work contains in addition a general bibliography, a useful glossary and a good index.

A careful examination of this book of Winton and Moeller's shows that in order to carry on analyses of vegetable food products successfully it is essential for the analyst to have special botanical training, and that with the knowledge gained by this training the determination of purity and the detection of adulterants is reduced to a degree of scientific accuracy hardly possible in any other kind of analytical work. The teachers of chemistry and those in the biological departments of colleges and technical schools should cooperate in arranging courses which would not only qualify their students to examine vegetable products, but also enable them to devise methods for their manufacture.

This book could be used as a text-book, and will be found an invaluable reference book for the food analyst, the agricultural chemist, the pharmacist and others engaged in the examination of foods, as well as the physician who may be called upon to identify vegetable substances in stomach contents and feces.

HENRY KRAEMER.

Essentials of Crystallography. By EDWARD HENRY KRAUS, Ph.D., Junior Professor of Mineralogy in the University of Michigan. Ann Arbor, Mich. 1906. Pp. 162; 427 figures.

Unlike some related sciences crystallography is not over-burdened with texts, certainly not with those printed in the English language. The appearance, therefore, of a new crystallography is an event of considerable importance to teachers of mineralogy. The author of 'Essentials of Crystallography' was trained in the laboratory of Professor Paul v. Groth, of Munich, and in the two brief years that he has been in the faculty of the University of Michigan, has developed a flourishing department which already requires the services of a professor, an instructor and two assistants.

Most writers of books upon crystallography appear to go out from the idea that the subject is adapted to study by a very limited number of persons, and those only who are to become thorough masters of the subject and advance it through original research upon general lines. Thus the texts published in England have laid stress upon mathematical theorems rather than upon the symmetry of crystals. The great development of organic chemistry in recent years, and the prominence which crystal symmetry and habit have acquired as means for identifying chemical compounds, has demonstrated that crystallography is a necessary part of the training of chemists as well as of mineralogists and geologists. For such students much must be eliminated from consideration in order that essential facts may be grasped, and the course be given a practical value.

The requirements of such students were singularly well met by the 'Elements of Crystallography' of the late George Huntington Williams, as was, perhaps, shown by the rather extensive use of the book by American teachers. Since the profound changes brought about by the acceptance and introduction of Gadolin's thirty-two classes of crystals, Williams's work has been no longer serviceable as a text, and its place has not been filled by any later work.

Professor Kraus apparently makes the fundamental assumption that crystallography can not be learned outside of a crystallographical laboratory or without the guidance of a

teacher. He has thus been able to cut down his text to 160 pages and to offer his book for sale at a price corresponding to one cent per page. The large number of figures for a book of such small compass, shows that so far as possible the training is to be through the eye, and the identification of models and crystals made easy.

The order of treatment is by systems and their subordinate classes, beginning with the forms of highest symmetry; and the holohedrism, hemihedrism and tetartohedrism of forms is indicated, though made secondary. The systems of nomenclature of Weiss, Naumann and Miller are used side by side. The relationships of the forms belonging to classes within the same system are indicated by tables and diagrams, in which the apparently holohedral forms and those which bring out in their development the real symmetry of the group, are sharply differentiated.

The six pages devoted to compound crystals will seem to many inadequate, in view of the great prominence of twins in the case of a large number of species. Not the least valuable part of the work is an appendix giving a tabular classification, which shows the symmetry elements and the simple forms of each of the thirty-two classes of crystals.

William Herbert Hobbs.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for November contains three long papers: 'Variation in the Number of Seeds of the (American) Lotus,' by Raymond Pearl; 'The Causes of Extinction of Mammalia,' by Henry F. Osborn; and 'A Preliminary Study of the Finer Structure of Arcella,' by Joseph A. Cushman and William P. Henderson. Professor Osborn's paper, which is to be continued, discusses seriatim the external causes, such as variations in climate, increasing cold, heat or moisture, with their concomitant changes in plant and insect life; and the relations of plants and insects to mammals, with their bearing on extinction. Discussion is desired and criticisms and suggestions will be welcomed. Messrs. Cushman and Henderson show that the generally accepted idea of the structure of the test of *Arcella* is incorrect, and that the framework instead of consisting of simple hexagons, touching one another at their sides, consist of hexagons touching at their angles and thus leaving triangular interspaces which permit the interpolation of new columns of hexagons as growth proceeds. There are many ichthyological notes, while those relating to botanical publications are, as usual, numerous.

The American Museum Journal for October is termed the Sponge Number, the principal article being 'A Guide to the Sponge Alcove in the American Museum of Natural History,' by Roy W. Miner. This is well written and well illustrated. Incidentally, it may be remarked that it is very difficult to find in any text-book a consecutive definition of a sponge; we are told all about the structure and embryology of sponges, but what a sponge really is and its position in the animal kingdom has to be gathered by much reading. The *Journal* contains brief reports of several of the Museum expeditions, including those to Tahiti, Colorado, North Carolina and East Africa.

The Museum News of the Brooklyn Institute for December has articles dealing with 'The Question of Common Names' and, in connection with a recently installed group, 'The Golden Eagle, its Haunts and Habits.' It is noted that the museum has acquired the Ward collection of sponges and corals, the former containing 150 specimens of siliceous sponges and 660 of horny sponges; the latter comprising 234 species of corals. The collection of sponges was brought together by the late Professor Henry A. Ward and is extremely valuable from both the scientific and the popular standpoint, comprising as it does selected specimens from many years of collecting. The leading article of the Children's Museum section, under the title of 'General and Mrs. Green,' deals with two bullfrogs that have lived in the museum for four years.

SOCIETIES AND ACADEMIES.

THE AMERICAN PHYSICAL SOCIETY.

The fall meeting of the Physical Society was held in Chicago on December 1. In the absence of President Barus, Past-president A.

A. Michelson occupied the chair. The meeting was well attended, members coming not only from the vicinity of Chicago, but also from points in Kansas, Iowa, New York and Nebraska, more than five hundred miles distant.

A resolution was adopted urging upon the council the desirability of holding a regular yearly meeting in Chicago or some other suitable point in the middle west.

The following papers were presented:

JOHN E. ALMY, University of Nebraska: 'Spark Discharges in Gases and Vapors.'

BRUCE V. HILL, University of Kansas: 'On the Magnetic Behavior of Certain Alloys of Nickel.'

FREDERICK E. KESTER, Ohio State University: 'An Experimental Gyroscope for Quantitative Work.'

R. A. MILLIKAN and GEORGE WINCHESTER, University of Chicago: 'Upon the Discharge of Electrons from Ordinary Metals under the Influence of Ultra-violet Light.'

A. B. PORTER, Chicago: 'An Inanimate Demon.'

A. B. PORTER, Chicago: 'On Multiple Crossed Gratings.'

A. A. MICHELSON, University of Chicago: 'On the Ruling of Diffraction Gratings.'

H. G. GALE, University of Chicago: 'The Effect of Temperature on Metallic Spectra.'

C. E. MENDENHALL and L. R. INGERSOLL, University of Wisconsin: 'The Radiation Constants and Temperature of the Nernst Glower.'

K. E. GUTHE and C. L. VON ENDE, University of Iowa: 'Standard Cells.'

F. L. BISHOP, Bradley Polytechnic Institute: 'Heat of Dilution.'

LAWRENCE E. GURNEY, University of Idaho: 'The Viscosity of Water at Low Rates of Shear.' Introduced by A. A. Michelson.

FREDERICK E. KESTER, Ohio State University: 'The Bridge Method for Comparison of Condensers.'

A. H. TAYLOR, University of Wisconsin: 'A Method for the Determination of Electrolytic Resistance and Capacity.'

C. F. LORENZ, Johns Hopkins University: 'On the Effects of the Electrical Discharge on the Acetylene Flame.'

WM. R. BLAIR, University of Chicago: 'Change of Phase due to the Passage of Electric Waves Through Thin Films and the Index of Refraction of Water for Such Waves.'

WM. W. COBLENTZ, Bureau of Standards, Washington: 'The Temperature of the Moon.' (By Title.)

F. W. VERY: 'The Temperature of the Moon.' (By Title.)

ERNEST MERRITT, Cornell University: 'Note on the Fluorescence of Sodium Vapor.'

H. V. MCCOY and W. H. ROSS, University of Chicago: 'The Relation between Uranium and Radium.'

ERNEST MERRITT,
Secretary.

DISCUSSION AND CORRESPONDENCE.

'ELIMINATION' IN FIXING GENOTYPES.

TO THE EDITOR OF SCIENCE: The valuable article on this subject by Mr. Witmer Stone, in SCIENCE for November 2, contains a list of twenty-five systematists to whom certain problems were submitted. The names given are all those of well-known workers in the United States, and I wondered why Mr. Stone had made no attempt to obtain the opinions of his foreign colleagues. The reason was found in the penultimate paragraph: "Elimination has never been practised in Europe and does not seem to be understood by foreign writers." Possibly it did not occur to Mr. Stone that, if foreign writers had never practised elimination, it might have been because they had always shared his unfavorable opinion of the method, and not from any lack of intelligence. The statement, however, is incorrect; at least some of us in the British Museum, who assuredly did not get our training in systematic zoology from any other part of the world, have always practised elimination when other principles, such as the fixing of a genotype by the author or the first reviser, did not intervene. I will accept Mr. Stone's assertion that we do not seem (to him) to understand the matter; but I hope to convince him that some of us do understand it at least as well as the majority of those who have replied to his questions. While reading his article I jotted down in the margin my answer to each question, and finished doing so before turning the page. The result was as follows: My answers to questions I, II, III, IV*b*, V*a*, V*b*, V*c*, VI, VII*a*, VII*b*, VIII*a*, that is to eleven out of thirteen questions, were in agreement with the majority. In VIII*b* there was no majority,

since 4 say 'sp. 4' and 4 say 'sp. 3'; I agree with the latter. In IV*a*, 7 say 1855, 8 say 1880, one says date when synonymy was first recognized: the answer depends on the meaning of the word 'removed'; if this be taken literally, the answer is 'either 1880 or any previous date when the synonymy may have been recognized'; but if we regard the spirit of the question, it will be obvious that when a genus is once established it includes all species congeneric with its genotype whether they have been 'removed' to it or no—therefore my answer was 1855. Ambiguity in this question may have been the cause of the equality of votes. In the case of question VI, the pronounced majority is perhaps due to ambiguity in the answer: what I say is that the reviser can not select as genotype of an early genus any species that is already genotype of a subsequent genus, so long as there remains any species free among the originally included species; therefore I wrote 'yes' to the first clause of the question, and 'no' to its second clause.

Adding my replies to those given, it appears that I agree with the majority, usually a large absolute majority, in twelve out of the thirteen cases, and that the thirteenth case, which is ambiguous, is a draw. After this Mr. Stone will probably admit that the method is understood by me, and he will perhaps accept my assurance that I am only an insignificant unit among a fairly large number of old-world writers of similar views and all provided with the small amount of intelligence required.

The considerable agreement attained by those who have answered his questions should prevent the wholesale condemnation of the elimination method; but it would add interest to the figures if we were told whether the minority was generally composed of the same writers. If so, they would probably yield only to *force majeure;* but if not, they might be brought into line by gentle argument.

Mr. Stone makes out a very strong case for the 'first species' method; but is he correct in saying that it 'can lead to but one result'? Would he kindly refer to *Annals and Mag. Nat. Hist.* (2), XVI., pp. 95, 96, and say what, on that method, is the genotype of *Hemipedina*?

F. A. Bather.

London, England,
November 12, 1906.

SPECIAL ARTICLES.

POLYEMBRYONY AND THE FIXING OF SEX.

Naturalists have long been familiar with certain curious and unexplained phenomena connected with the life histories of certain parasitic hymenopterous insects of the family Chalcididæ. DeGeer in 1752 figured a minute black species with dirty-white wings, which he reared from *minute cocoons* attached together side by side in the larva of one of the pear-leaf miners. Westwood, in the second volume of his Introduction, says of this insect: "The figure has somewhat the air of *Encyrtus;* but the pupæ are naked in that genus."

In the *American Naturalist* for February, 1882, in the second installment of an article entitled 'On some Curious Methods of Pupation among the Chalcididæ,' the writer described a precisely similar object found in the mines of an oak-leaf miner, *Lithocolletis fitchella,* at Washington and bred from it a number of specimens of an encyrtid of the genus *Copidosoma.* He further described somewhat similar cocoon-like formations within the larval skin of the pine-leaf miner, *Gelechia pinifoliella;* also in the skin of the larva of the twig borer, *Anarsia lineatella,* in the larva val skin of the pine-leaf miner, *Gelechia pinisolidaginis*), and finally described at some length the strange habits of a congeneric parasite which attacks the larva of *Plusia brassicæ.* The latter was described as follows:

> The *Plusia* larva, up to the time of commencing to spin, appeared quite healthy, although perhaps a little sluggish. Then suddenly its torpor increased, and through the semitransparent skin were seen hundreds of small white parasitic larvæ. In two days at the most the host was dead, having perhaps partially finished its cocoon, while its entire body was completely packed with the parasitic larvæ or pupæ, each surrounded by a cocoon-like cell. A cross-section of the host at this stage showed a regular honeycombed structure. After remaining in the pupal state not longer than twenty days, the chalcidids com-

menced to emerge by the hundreds. My friend, Mr. Pergande, took the trouble to count the parasites which actually issued from one *Plusia* larva, and, to our utter astonishment, the number reached 2,528. An interesting problem now presents itself as to the nature of the cocoon-like cell surrounding each chalcidid pupa in all these different hosts from *Lithocolletis* up to *Plusia*. In the first place it is no silken cocoon, as is readily shown by the microscopic structure. Neither is it a membrane secreted in the general surface of the chalcidid's body, for but a single wall exists between two adjoining pupæ. For the same reason it is not the loosened last larval skin of the parasite. But one hypothesis remains, and that is that it is a morbid or adventitious tissue of the host. * * *

The same phenomenon was referred to by the writer in *Insect Life*, Vol. IV., p. 193, with illustrations, and again in his paper on the 'Biology of the Hymenopterous Insects of the Family Chalcididæ,' in the *Proceedings of the U. S. National Museum*, Vol. XIV., p. 582 (1892). In the latter paper the statement was made that in no case had it been possible to count over 160 eggs in the ovaries of a single *Copidosoma*, and that the number of parasites issuing from a single *Plusia*, therefore, was puzzling and only to be explained on the ground that several females oviposited in a single larva at the same time, as all larvæ develop together, and transform together, and issue nearly together.

In the meantime E. Bugnion, in a most interesting and important paper entitled 'Recherches sur le Développement Postembryonnaire, l'Anatomie et les Moeurs de l'Encyrtus fuscicollis' (*Recueil Zool. Suisse*, Vol. V., pp. 435–536, 1891) had studied with care one of these interesting insects parasitic upon a little Tineid larva, *Hyponomeuta cognatella*, and he found that if one opens the little caterpillar at the end of April or the first half of May, almost always, or at least with some of them, the embryos of the *Encyrtus* (or *Copidosoma*) will be found associated together in the form of chains or strings. These chains are composed of from 50 to 100 or even 120 individuals. The sac which contains the parasites looks like a whitish tube, often bi- or trifurcate, flexuous, folded upon itself, floating in the lymph of the caterpillar outside of the intestine. Formed of a cuticular membrane, it is clothed on the interior with a layer of epithelial-like cells and encloses a fatty-albuminous mass in which the embryos are enclosed. Later, according to the observations of Bugnion, when the larvæ have attained a certain size, say at the end of May or the beginning of June, the string or chain, which may be 3.5 cm. long, presents a series of swellings and constrictions. Each swelling contains an undeveloped larva in the nutritive substance. At the end of June, the parasites having passed their first molt, break the epithelial tube which envelops them, and find themselves free in the body of the caterpillar. This period (second larval stage) lasts about eight days. Finally the larvæ, having cleaned out the interior of the caterpillar, each one pupates by enclosing itself in an ovoid cocoon, and the caterpillar, whose skin molds itself exactly upon these cocoons, becomes only a rigid, bossy mass. The change from the larva to the nymph takes place by a new molt, and about twenty days afterwards the *Encyrtus* emerges.

In 1898 Alfred Giard (*Bul. Soc. Ent. France*, pp. 127–129) published a note on the development of *Litomastix* (*Copidosoma*) *truncatellus*, a parasite of *Plusia gamma*, in which he describes precisely the same phenomenon previously described by the writer with the same parasite infesting *Plusia brassicæ*, but he reared more than three thousand specimens of the parasite from a single caterpillar. He showed that a single female can lay not more than a hundred eggs and that, therefore, since all of the parasites emerge at the same time, it is almost necessary to suppose that several females (twenty-five to thirty) simultaneously attacked the caterpillar. This, however, Giard thought was most unlikely, and he believed, therefore, that the phenomenon with *Plusia* must be explained on the basis of Paul Marchal's preliminary note published the same year. This leads us to Marchal's observations.

Dr. Paul Marchal, entomologist of the agronomic station under the Ministry of Agriculture at Paris, a naturalist trained in

the very latest morphological methods, a skilled embryologist, and a man of broad culture, in 1897 began to study the development of *Encyrtus fuscicollis*, a parasite of several species of the genus *Hyponomeuta;* publishing his preliminary announcement of his first discovery in the same year, indicating that from a single egg of the parasite there develop many true embryos. His announced results were received with the greatest interest in France, as evidenced by the appreciative remarks of Giard in his own article just cited.

With an admirable skill, with extreme powers of observation, and with an indomitable perseverance, Marchal continued these investigations during six or seven years, publishing four important papers, and finally, in 1904, his startling work entitled 'Recherches sur la Biologie et le Developpement des Hymenopteres Parasites'—La Polyembryonie Specifique ou Germinogonie, *Arch. Zool. Exp.* (4), Vol. II., pp. 257–335, pl. IX.–XIII.

The facts upon which he throws light may be summed up as follows, and in this summary the writer follows Bugnion:

1. The *Encyrtus* [*Litomastix* or *Copidosoma*] has, as well as its host the *Hyponomeuta,* a single annual generation.

2. The oviposition of the *Encyrtus* takes place after that of the *Hyponomeuta,* in July or in August, according to the species parasitized, and it is in the egg of the moth that the parasite introduces its own egg.

3. Each chain of embryos comes from a single egg, following the division of the germ into several distinct individuals in the morula phase.

4. A *Hyponomeuta* egg receives ordinarily only one *Encyrtus* egg. While it is possible that the *Hyponomeuta* egg may be pierced two or three times (perhaps by different individuals), in each case it forms in the caterpillar a corresponding number of chains of embryos.

5. The nutritive mass in which the embryos are encased results from the proliferation of the amniotic cells furnished by the germ of the *Encyrtus* (derived from the paranucleus).

6. The anhiste membrane, as well as the epithelial-like cellules which clothe the interior, are formed at the expense of mesenchymatal elements furnished by the organism of the host. These formations can be assimilated to an adventitious cyst destined to isolate the parasites.

It is upon the eggs of *Hyponomeuta malinella* that the act of oviposition of the *Encyrtus* was for the first time observed (1897).

Marchal having enclosed a branch of apple in a covering of gauze, placed some cocoons of the moth within. The adult insects emerged during the latter part of June and the early part of July. On the fourth several pairs copulated. On the sixth several freshly deposited egg masses were seen on the branches. On the eighteenth, a large number of *Encyrtus* having issued from parasitized caterpillars placed in the cage, Marchal noticed at half past one in the afternoon (at the time when the rays of the sun were warmest) an *Encyrtus* which, poised upon an egg batch of the *Hyponomeuta,* seemed to be about ovipositing. Profiting by such a favorable opportunity, he was able, during the four succeeding hours, to follow with a lens the minute parasite which passed from one egg batch to another, piercing the eggs with its ovipositor. The operation lasted each time a little more than half a minute (two minutes toward the end of the day).

Other observations were carried on upon the parasites of *H. mahalebdella.* As this insect issues later than the others, Marchal was able, thanks to this fact, to obtain new layings of the *Encyrtus* through a period extending from the twelfth to the twenty-second of August, and to complete at the same time the material which he needed for his work. He concludes from his latest observations that the *Encyrtus* does not live more than a dozen days in the imago state.

The search for the egg of the *Encyrtus* in the egg of the *Hyponomeuta* being extremely difficult if one is obliged to dissociate the vitellus, Marchal used the method of cross-section. Having collected on the tenth of September, 1901, the parasitized egg masses of *H. mahalebdella;* having fixed them in Gilson's liquid, colored with carmine and having cut them into fine sections, he succeeded in

discovering the egg of *Encyrtus* enclosed in the general cavity of the embryo of the *Hyponomeuta* already voluminous and well advanced. The size of the egg is so small that it was not possible to make more than four or five serial sections of its substance. Its contour is ovoid, distinctly limited, and there is no trace of the shell and pedicel observed before laying. There are in the interior five nuclei in the as yet undivided protoplasmic mass, of which four are smaller, rounded, equal in size, and one more voluminous, placed excentrically, of an irregular lobate form, presenting a finer and denser reticulum. It may be stated that the four little nuclei are destined to engender by successive proliferation all the chain of embryos while the larger nucleus (paranucleus or amniotic nucleus) constitutes the first outline of the amnion.

At this stage the egg of the *Encyrtus* is not surrounded by any membrane. One observes only in its neighborhood the presence of certain mesenchymatous cellules belonging to the host. It is a little later, when the number of embryonic nuclei has risen to eight or ten, that an adventitious cyst commences to form by the drawing together of the mesenchymatous elements which apply themselves against the egg and form a clothing of even cellules. As to the amniotic cellules derived from the paranucleus, their rôle is to form the albumino-fatty mass which surrounds the embryos and which serves indeed as food for the young larvæ.

At the end of September the little larvæ of the *Hyponomeuta* hatch, but they feed only upon the débris of the eggs and remain until springtime protected by the covering of the egg mass. In opening these larvæ under the microscope it is noted with certain ones that there are sometimes two or three little rounded bodies still difficult to distinguish floating among the viscera. These little bodies are the eggs of the *Encyrtus*. Examined by transmitted light at the end of autumn, the egg shows a globular or ovoid mass of protoplasm in which are situated, first, a mass of embryonic nuclei pressed together to the number of from fifteen to twenty; second, a large excentric paranucleus frequently divided into two segments.

This condition just described persists almost without modification through the winter. Meanwhile in a considerable number of eggs may be found, in the month of March and even in February, a grouping of the embryonic nuclei which already announces the division of the germ into several embryos. The formative vitellus (characterized by its clear tint) is divided into several rounded masses isolated from each other and each surrounding a group of nuclei. These last, which formerly had two nucleoli, now show multiple nuclei often placed in two rows.

But the phenomenon of polyembryony reaches its greatest intensity at the period when the young larvæ of the *Hyponomeuta* leave their winter shelter and commence to eat the leaves.

The egg, at first spherical, grows with an extraordinary rapidity and takes upon itself little by little an elongated ellipsoidal form. It is of this shape and with a considerably increased diameter that it is found in the interior of the larvæ of *H. cognatella* about the twentieth of April. The same condition is found in *H. mahalebdella* toward the tenth of May.

Studied at this time in a fine cross-section, the germ of *Encyrtus* is found to be composed of small, rounded masses, which have already in certain instances commenced to shape themselves at the end of winter.

Having become more numerous, these are formed of small collections of protoplasm surrounding the nuclei (to the number of eight to twelve to each mass) and offering already quite distinct cellular limits. Each one of these masses is lodged in a round and well-differentiated cavity hollowed out of the common nutritive granular protoplasm. These bodies, which may be likened to gemmules and which may be called hereafter muriform, increase by the multiplication of their elements until reaching a certain size—each one comprising then twelve to fifteen cellules—they divide by cleavage.

In the latter days of April, when the complex polygerm of *Encyrtus* has reached a half

millimeter in length and has taken the form of a sausage, there are about forty muriform bodies in the interior, all distinct from each other and surrounded by the common granular mass. The number of cellules which composes them is always somewhat reduced.

Toward the middle of May the complex polygerm has become a string of from three to four millimeters in length; the gemmules have multiplied until they are often more than a hundred. They have on an average twenty to forty cellules which, by reciprocal pressure, seem polygonal. From this period the embryonic buds begin to issue and the form of the body to become fixed. The embryo, abandoning its spherical form, becomes more discoidal and takes on a reniform aspect. This very characteristic form is generally found about the twenty-fifth of May with *H. cognatella*. Finally toward the tenth of June, the embryo having passed to the larval condition, the chains of the *Encyrtus* reach their definite length and show the typical form described at the beginning of this article.

The most striking fact in the development of the *Encyrtus* is then that a single egg placed in the egg of the moth proliferates by the division of the nucleus in such a way as to form a certain number of plurinuclear masses, and that these, dividing in their turn, give rise to as many morules as there will be embryos in each of the chains.

Polyembryony being, as appears from what precedes, the ordinary method of development of *Encyrtus fuscicollis*, one can predict that the study of the Chalcicidæ, especially of the Encyrtinæ, will show other analogous cases.

Marchal cites already *Ageniaspis testaceipes* Ratz., parasite of *Lithocolletis cramerella*, a miner of oak leaves. He has been able to see, it is true, only the advanced stages of the evolution of this species, his observation having been made in the month of October. The larvæ to the number of twelve or fifteen to each caterpillar had for the most part already formed their cocoons. But in some caterpillars the parasites were grouped in an epithelial tube similar to that of *E. fuscicollis*. The structure of the tube being absolutely the same, it is probable that the development goes on in the same way.

Another case of polyembryony has been observed by Marchal: *Polygnotus minutus* Lindeman, a minute prototrypid, .5 mm. long, parasite of the Hessian fly. The embryos, which are found to the number of ten to twelve in the gastric sac of the larva of the Hessian fly, are grouped in such a manner as to form a single ovoid mass.

The author, it is true, has not observed the *Polygnotus* in the act of oviposition, but, having found freshly-laid eggs in the gastric cavity, he has succeeded in following the multiplication of the nuclei, then the grouping of the cellules in several individuals as distinctly as with the *Encyrtus*. Polyembryony is then well established for this species. The only differences from *Encyrtus fuscicollis* are, first, that to the morula stage succeeds a true blastula with a central cavity before the formation of the embryo; second, that the proliferation of the germ being much less active, the number of individuals issuing from the egg does not appear to exceed twelve.

Following the publication of this remarkable paper, the subject of polyembryony was taken up by Dr. Filippo Silvestri, of the Royale Scuola Superiore di Agricoltura, at Portici, Italy, who published in 1905 a paper entitled 'Uno Nuovo Interessantissimo Caso di Germinogonia,' etc. (*Rendiconti della R. Accademia dei Lincei*, Vol. XIV., 2d sen., Serie 5ª, fac. 10°), which consisted of a preliminary note on the study of polyembryony with *Litomastix truncatellus*, the same species which had been observed by the writer and by Giard.

In 1906, in a paper entitled 'Contribuzioni alla Conoscenza Biologica degli Imenotteri Parassiti,'[1] the same writer, Silvestri, goes into detail, with text figures and plates, regarding a most interesting series of observations, in which he sums up practically as follows:

Litomastix truncatellus lays its egg in the egg of *Plusia gamma*.

[1] 1. Biologia del Litomastix truncatellus (Dalm.); 2d. Nota Preliminare, Portici, 1906, pp. 1–45, pl. I.–V.

The larva of *Plusia* parasitized by the *Litomastix* lives in summer three or four days longer than the healthy larva and reaches a greater size.

Each generation of the *Plusia* corresponds to a generation of the *Litomastix*.

The maturation of the egg is identical with fertilized and unfertilized (parthenogenetic) individuals. In the development of the egg of the *Litomastix* we have a process of germinogony or specific polyembryony, quite different from that found by Marchal in *Encyrtus fuscicollis* and *Polygnotus minutus*.

From one egg of *Litomastix* there originate about a thousand sexual larvæ and some hundred or more asexual larvæ. The first transform into adults, while the second are destroyed, serving probably as aids to the sexual larvæ in lacerating the internal organs of the host larvæ.

Asexual larvæ are notable from their form, in the structure of the exoskeleton, and by the lack of a circulatory system, of a respiratory system, of the malpighian tubules, and, above all, of the reproductive system.

Each embryo of the sexual or asexual larva is surrounded by two involucres, of which the external one is derived from the ooplasm and the polar nucleus; the internal from a layer of cellules derived by delamination from the embryonal morule.

The fecundation of the egg with *Litomastix* determines the female sex.

And now, what are the broad bearings of this interesting work?

Giard had already in 1898, in his note cited above, in discussing the value of Marchal's discovery as announced in his preliminary note, stated that if one wishes to seek in other classes of animals embryonic peculiarities comparable to those revealed by Marchal, it is perhaps in the degraded platyhelminths of the families Orthonectidæ and Dicyemidæ that something analogous may be found. The sporocysts of *Rhopalura* are in effect, he stated, filled with embryos by a process of ovular multiplication which is not unlike that which takes place in the embryonal tubes of the *Encyrtus*.

Marchal himself publishes an important section entitled 'Relations existing between Specific Polyembryony of the Hymenoptera and Other Modes of Agamic Reproduction.' These instances are well summed up by Bugnion in a paper entitled 'La Polyembryonie et le Déterminisme Sexuel' (*Bulletin de la Société Vaudoise des Sci. Nat.*, XLII., No. 153, March, 1906), in which he also includes a consideration of certain additional observations, and we may adopt in a very free translation Bugnion's summary:

Other examples taken from the whole range of the animal kingdom somewhat approach the polyembryony of insects.

With the cyclostomes (Bryozoa) one finds a budding which takes place in the egg at the beginning of development. In the genus *Lichenopora* this budding is replaced by the dissociation of the primitive embryo into a great number of secondary embryos. We have then here a phenomenon comparable to that which we have seen with the parasitic Hymenoptera. It is necessary to note, however, that the secondary embryos thus formed offer already an indication of embryonic buds, while the morules of *Encyrtus* or the blastules of *Polygnotus* present no apparent differentiation. With other Bryozoa (*Lophopus, Cristatella*) there is also to be seen a budding in the egg, but this takes place at a later period.

With the worms, Kleinenberg announced in 1879 the curious case of *Lumbricus trapezoides*, in which the egg develops into two embryos; here the multiplication takes place by a sort of internal budding intervening in the gastrula stage, at which time differentiation of the buds is already effected.

With the tunicates, the species of *Diplosoma* offer a curious case of precocious budding which gives the appearance of the simultaneous formation of two embryos in the same egg, but in reality this proceeds from the internal budding of an embryo already differentiated (Salensky, Caullery, Pizon, Perrier). With *Pyrosoma* the budding also takes place in the egg, but by a slower method, and it is only when the embryo is organized that it pushes out a ventral stolon immediately cleaving transversely into four buds which each

develop into a new individual (according to Huxley, Kovalevsky, Seelicer, etc.).

From the cases mentioned, where the budding takes place in the egg, one passes insensibly to more frequent and better-known phenomena in which agamic reproduction takes place after the individual has already issued from the egg (as in the Cœlenterates, Orthonectidæ, Dicyémidæ, Platyhelminths, Tunicates). The preceding observations seem then to establish a continuous series connecting the polyembryony of Hymenoptera with the cases of agamogenesis occurring in advanced stages of development.

In general the facts of polyembryony may be also said to approach the cases of experimental blastotomy recently observed by various authors.

Dreisch (1892), passing a temperature of 31° over the eggs of echinids, obtained a separation of the blastomeres into two or more groups; and Loeb (1893), by mixing distilled water in equal parts with the sea-water in which the eggs were found, produced the same result.

Another experiment of Loeb, 1894, upon the eggs of *Echinus*, and by Bataillon, 1900, upon the eggs of *Petromyzon* and of teleosts, consists in dissociating the egg into several groups of blastomeres by means of a heated needle. Both obtained complete larvæ, each blastomere or group of blastomeres forming an embryo.

Ryder in 1893 obtained double monsters by the shaking of the eggs of trout. The vitellus forming on both sides of the egg made two distinct individuals.

One can even make two complete larvæ of *Triton* united only by the skin of the abdomen, by constricting the egg with a silken thread (Endres 1895, Speman 1900 and 1901).

These facts favor, it may be seen, what is called the isotropic condition of the egg, each blastomere or group of blastomeres isolated by one of the methods indicated being capable of forming a complete individual.

Marchal expresses this very well in saying that both in spontaneous polyembryony and in experimental blastotomy each part of the egg contains the complete hereditary patrimony capable of ending in the formation of an individual conforming to the specific type.

In the papers of Marchal and Bugnion no reference is made to the recent very important work of Professor Conklin in which he shows that the eggs of the Ascidians, *Cynthia partita* and *Ciona intestinalis*, are not isotropic and that the cytoplasm of the egg is not equipotential. Dr. Conklin concludes that "Experiments which demonstrate the totipotence of blastomeres or regions of the egg prove nothing with regard to the presence or absence of differentiation in these parts. Some eggs with a high degree of differentiation have at the same time great capacity for regulation." Workers in this field must reckon with these important results.

Another question which presents itself is that of knowing whether among insects polyembryony ought to be considered as having preceded or followed phylogenetically the other methods of agamic reproduction such as pædogenesis among the Cecidomyiidæ or cyclical parthenogenesis among the Aphididæ and the Cynipidæ. Harmer, for the Bryozoa, arrived at the conclusion that embryonic scission is a consequence of the blastogenetic faculty of the adults. Perrier extends the same point of view to all budding animals.

Considered from this point of view, the polyembryony of the Chalcididæ appears not as an initial phenomenon, but as a secondary adaptation due to an acceleration of embryogenetic process (*tachygenesis* of Perrier, 1902). The result of this adaptation is, considering the short and precarious existence of the adult *Encyrtus*, to assist in the preservation of the species by pushing its multiplication to the highest possible degree.

As to the determining cause of the division of germ, Marchal thinks that it is from the sudden surrounding with more dilute liquids in the interior of the nourishing mass and in a concomitant modification of the osmotic exchanges in the interior of the cellules. One sees, in fact, with *Encyrtus* that polyembryony reaches its greatest intensity at the moment when the larva of the *Hyponomeuta* commences to feed (in the early days of April), and for the *Polygnotus* at the period

when the young larva of the Hessian fly engorges itself with sap. Now, the production of the rapid changes bringing about osmotic pressure constitutes precisely the procedure employed to bring about the separation of the blastomeres and their evolution into several distinct individuals, as has been shown by the experiments already mentioned of Loeb and Bataillon.

Polyembryony is connected with the question of the fixation of sex, and offers from this point of view an especial interest.

Bugnion observed already in the course of his studies upon *Encyrtus* (1891) that all of the individuals coming from a single caterpillar most often belonged to a single sex. A total of twenty-one observations carefully controlled gave the following result: five times of males exclusively; nine times of females exclusively; three times a great majority of males; once a great majority of females; three times males and females in nearly equal numbers.

Marchal has stated similarly that with *Polygnotus,* those coming from a single larva of the Hessian fly almost always belong to the same sex.

These facts, which Bugnion thought should be attributed to an occasional parthenogenesis (the caterpillars giving birth exclusively to males having been, according to his supposition, those which had been pierced by a non-fertilized *Encyrtus*), are now to be explained in a much more rational manner.

With man, true twins enclosed in the same chorion probably come from a single egg. While different hypotheses have been suggested, especially lately (Rosner, 1901), it is natural to suppose that twins develop by the separation of the egg into two parts (spontaneous blastotomy). Then it is established that true twins are always of the same sex. Exceptions to this rule are explained by the fact that certain unusual twins are formed by the joining of two eggs.

Another case presents itself with the mammals, which seems much more comparable to those of *Encyrtus* and *Polygnotus,* namely, that of the armadillo (*Dasypus* or *Tatusia*). These animals give birth, according to the species, to a litter of from four to eleven young which are all and always of the same sex. It has been noted by Ihering (1886) that all of the fœtuses are enveloped in a common chorion and belong, therefore, to the type of true twins. Rosner (1901) explains this fact by the habitual presence of several ovules in a single graafian follicle, and has even concluded that all of the cases of monochorial multiple birth can be explained in the same way. But Cuenot (1903), reviewing the question, has found that with the species studied by Rosner (*Tatusia novemcincta* Linnæus) the monovular follicles are twenty times more numerous than the pluriovular follicles. It is then impossible to admit that the latter only furnish the fertilizable eggs, and the author concludes that, according to all probability, the multiple births of armadillos come from a single egg.

The discovery of Marchal, therefore, comes extremely apropos to throw new light upon this interesting and greatly discussed question. In the cases where *Encyrtus* and *Polygnotus* issuing from the same larva are almost all males or all females, it must be admitted that this is a natural consequence of polyembryony, and that one would expect the sexes to be separated in this way wherever the embryos come from the division of a single egg.

The fundamental fact coming from this study is that every caterpillar or larva which contains a single chain of embryos gives birth to imagos of the parasite belonging to a single sex, but as the same caterpillar frequently contains two or three chains it will not be astonishing to find males and females given out in quite equal number. The cases in which we find individuals of both sexes, but in unequal numbers, are to be explained by the partial aborting of one of the chains and the survival of only a few individuals, while the other chain develops normally.

It is seen, therefore, that the discovery of polyembryony confirms a fact already suspected but until now incompletely demonstrated, and that is that *the determination of the sex in the fecundated egg is definitely brought about before the first segmentation*

of its nucleus. If then the facts drawn from the observation of parasitic Hymenoptera apply equally to the higher animals, it will be inexact to speak, as has sometimes been done, of an embryonic period which is indifferent from the sexual point of view. The indifference is probably apparent rather than real, and it appears probable that once fecundation is effected the sex is irrevocably fixed.

It is strange that Marchal's work and that of Silvestri following it have received so little attention from English-speaking naturalists.

The extraordinary nature of the discoveries and their wide bearing upon profound biological problems render them among the most important discoveries in biology of recent years. Recently published volumes on insects contain no mention of them; no competent reviews have been published in American or English journals, so far as I am aware, and it is for the sole purpose of directing the attention of American workers to this extremely important field that I have written this lengthy account. After reviewing one of Marchal's preliminary papers in SCIENCE in 1898, I endeavored to induce several university teachers, possessing well-equipped laboratory facilities, to take up the subject of this investigation, but without success. It is a fertile field. In the parasitic Hymenoptera there are many thousands of species, and an unlimited material exists at our very doors. The most promising fields of investigation have recently been pointed out by the writer in a paper read before the Entomological Society of Washington. Marchal has studied two or three species; Silvestri has studied another; and both workers have found radical and interesting differences in all. There is, therefore, a vast and unexplored field whose richness can well be predicted from the results of Marchal's work. L. O. HOWARD.

LE FONDULE (FUNDULA CYPRINODONTA) OF CARBONNIER AN UMBRA.

I HAVE been several times asked what the Fondule of Carbonnier (1874) was. The breeding habits of this American fish were noticed in considerable detail by P. Carbonnier in the *Bulletin Mensuel de la Société d'Acclimatation* for November, 1874 (pp. 665–671), but under a strange name which has evaded and even prevented identification. The article in question is entitled 'Le Fondule (*Fundula cyprinodonta* Cuv.)' and it is especially claimed: "Ce poisson américain a été désigné par Cuvier sous le nom de *Fundula cyprinodonta.*" But Cuvier never gave such a name to a fish, neither in the first or second edition of the 'Régne Animal,' nor (with Valenciennes) in the 'Histoire Naturelle des Poissons.' Carbonnier was probably told by some one who looked casually at his fish that it was a *Fundulus*, a cyprinodont, but the slight notice given of it by Carbonnier does not agree with any cyprinodont. The only means he has given to determine what it was are meager data respecting size, color, sexual differences and habits. The size was small—12 to 15 centimeters at most; there were numerous longitudinal parallel lines; there was no constant difference in color between the sexes, but the females were twice as large (bulky) as the males; they were noticeable for immobility[1] and also for apparent power to turn the head.[2] Here we have a combination of characteristics which is not true of any cyprinodont but which is on the whole realized by an Umbra or mudfish (*U. pygmæe*), and doubtless specimens of that mudfish (to be found abundantly about New York) were the fishes sent to Carbonnier. The sender was a 'M. Godillot,' a Frenchman doing business in New York, as appears from a previous notice by Carbonnier in the *Bulletin* (1871, p. 650).

Interesting details are given of the play of the sexes, the change in color during the nuptial season, the mode of oviposition, the care of the female for her eggs[3] and the char-

[1] L'immotilité qui est un caractère de cette espece (p. 666).

[2] J'ai dit elle tourne la tête, et avec intention, car cet organe chez le Fondule paraît ne pas être invariablement soudé à la charpente du tronc, et jouit, au contraire, d'une certaine mobilité (p. 669).

[3] Pendant tout le temps que dure l'incubation, qui est de treize à quatorze jours, la femelle veille avec une tendre sollicitude sur ses œufs (p. 669).

ecteristics of the larval fish. These were the first observations made on the breeding *Umbra* and should be repeated before they are fully accepted. Although many years ago I kept several specimens in a small aquarium, no attempt to breed was noticed, and none has been observed in an aquarium of the U. S. Fish Commission containing a number of them. I therefore call attention to the interesting article by Carbonnier.

THEO. GILL.

NOTES ON PHYSICS.

THE TUNGSTEN LAMP.

MANY readers of SCIENCE may be interested to know that 'the electric lighting industry is face to face with a change of almost revolutionary character,' to quote from the concluding paragraph of a paper read before the American Institute of Electrical Engineers by Dr. C. H. Sharp, of the Electrical Testing Laboratories of New York City, on Friday evening, November 23.

The two papers of the evening were, a paper by Dr. C. P. Steinmetz on the general aspects of the problem of the transformation of electric power into light, and one by Dr. Sharp on some tests of new types of incandescent lamps; and the subject was discussed by several investigators who are working upon the problem of the tungsten lamp in this country.

It is generally conceded that within a year an electric glow lamp, the tungsten lamp, will be on the market and that the output of light per unit of power consumed will be increased at least threefold above that which is now obtained by the carbon filament glow lamp; which means that the light-producing capacity of every electric lighting station in the world will be at once multiplied by three, and that there will be at once the possibility of greatly reduced prices per unit of light and greatly increased profits to the electric lighting companies.

Those who are interested in the scientific or technical aspects of the problem of electric lighting will find it worth their while to read the papers of Dr. Steinmetz and Dr. Sharp in the forthcoming monthly issue of the *Proceedings of the American Institute of Electrical Engineers.*

NORMAL VERSUS SELECTIVE RADIATION. SELECTIVE EXCITATION.

To obtain a highly efficient lamp is either to discover a substance which will stand an excessively high temperature under which conditions a very large percentage of the radiant energy is light, or to discover a substance which at a moderately high temperature radiates selectively and gives off a large percentage of luminous radiation. Thus the Welsbach gas light owes its high efficiency very largely to the selective radiation of thorium and cerium oxides.

The idea of selective radiation is, however, profoundly modified in most illuminants and made to depart widely from that form of the idea which is based upon thermodynamics, where the idea grows out of the necessarily complementary character (in a substance nearly in thermal equilibrium) of emission, transparency and reflection.[1]

This modification of the idea of selective radiation is so important in the problem of light production that it should be more generally recognized, and its very intimate connection with that principle in the kinetic theory of gases which is known as the principle of the equi-partition of energy should be pointed out. Indeed, this modification of the idea of selective radiation is intimately connected with the apparent inapplicability of the principle of the equi-partition of energy.

Jeans has shown that the apparent failure of the principle of the equi-partition of energy in a gas may be explained by the hypothesis that when energy is given to a gas in a particular form, say as energy of translational molecular motion, it takes a very long time for this energy to become properly partitioned among all the possible modes of molecular motion.

The application of Jeans's idea to the question of selective radiation is that when energy

[1] See Nichols & Franklin's 'Elements of Physics,' Vol. III., chapter on Radiation for an outline of the argument.

in a particular form is imparted to a substance it spreads out very slowly among the various possible modes of molecular motion and if the substance is losing energy continuously by radiation we must have a very wide departure from black body radiation because of the wide and persistent departure of the substance from thermal equilibrium. I think this departure of the radiation of a substance from black body radiation should be attributed to its actual cause, selective excitation, and it should not be spoken of as selective radiation in the strict sense of that term.

The extent to which the radiation from a selectively excited substance departs from black body radiation or rather from its own characteristic normal emission (when it is nearly in thermal equilibrium) depends greatly upon the speed at which the energy of a given mode of molecular motion spreads out into all the possible modes, and we have evidence that this speed of spreading is very slow even in many solid and liquid substances. Thus we have in the fire-fly a case of selective excitation and the wide departure of the radiation of the fire-fly from normal black body radiation shows that the energy which is developed by the selective excitation is nearly all radiated before it spreads out to any great extent among the various possible modes of motion.

In the case of the Welsbach mantle it is not at all certain that we have a genuine case of selective radiation free from the effects of selective excitation, for, although the exciting agent in this case is the extremely disordered movements of combustion, still even the disordered movements of combustion do no doubt depart very widely from the type of molecular motion which would exist in the same substance in thermal equilibrium.

When energy is imparted to a glowing substance by the electric current, whether the substance be solid, or liquid, or gas, we have in all probability a strongly marked case of selective excitation.

The upshot of this whole matter is that in the solution of the important problem of the efficient production of light we are not constrained by the thermodynamic laws of radiation, and not to a very great degree dependent upon selective radiation properly so called, but we are left free in the field of unlimited possibilities of selective excitation and we may look forward with some hope of a highly efficient lamp independently of the discovery of a substance which will stand temperatures of many thousands of degrees.

In the tungsten lamp we have certainly a filament which stands a very high temperature (several hundred degrees higher than the carbon filament can stand), we have a filament which certainly shows selective radiation in the strict sense of this term, and we have most certainly some degree of selective excitation. To what extent the high efficiency of the tungsten lamp is to be attributed to one or another of these three things it is impossible to decide from present data.

In the mercury-vapor lamp and in the titanium-arc lamp we have certainly a substance (a vapor) which can stand an unlimited degree of temperature, but we know that the vapor is not very hot in either case; also in both lamps the light-giving vapor most certainly shows selective radiation in the strict sense of this term, and in both cases we most certainly have very pronounced selective excitation. Furthermore, in the case of a gas or vapor it seems that the speed of spreading out of a given mode of molecular motion into all possible modes is very slow, so that selective excitation in a vapor or gas shows itself in very pronounced departure of the radiation from the normal characteristic radiation of the given gas or vapor.

The most striking instance of selective excitation as shown by extremely abnormal radiation is that afforded by the long-continued glow of the air in a Geissler tube *at liquid-air temperature* after the cessation of the exciting current. It seems, indeed, that the lower the temperature of a substance the slower the energy of a given exaggerated mode of molecular motion spreads into other modes, and the higher the temperature the more this spreading is accelerated. A remarkable consequence of which is that a selectively excited gas should be cold to give the greatest possible luminous efficiency, whereas a very hot gas

when selectively excited tends to give off perceptible intensities of radiation corresponding to every possible mode of molecular motion.

Another aspect of increased rapidity of spreading of energy among the various modes of motion of a gas with increased temperature is that the spectrum of a very hot gas when excited by the electric current tends to show many lines that are invisible when the gas is relatively cool. Thus the spectrum of the mercury arc has no red lines when the vapor is relatively cool, but when the vapor is very hot red lines appear.

W. S. FRANKLIN.

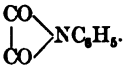
NOTES ON ORGANIC CHEMISTRY.

THE NITRATION OF ANILINE.

IT is generally stated in text-books of organic chemistry that aniline and nitric acid, of tolerably high concentration, yield resinous, tarry, or carbonaceous material from which no definite compounds can be isolated, whereas, in the presence of a large excess of concentrated sulphuric acid, nitration of the aniline takes place without difficulty. This behavior is explained by assuming that in the first case the nitric acid attacks the amino group of aniline more readily than it affects the benzene nucleus, but that the former is 'protected' by the concentrated sulphuric acid.

Several objections can be made to this explanation, among which the following may be mentioned: (1) Aromatic amines form stable compounds (nitrates) with nitric acid, but with nitrous acid the products (nitrites, diazonium derivatives, etc.) are, in general, highly unstable. (2) The primary products of the action of aniline on nitric acid or sulphuric acid are, presumably, aniline nitrate, $C_6H_5NH_2NO_3$, and aniline hydrogen sulphate, $C_6H_5NH_2SO_4H$, respectively, and it is not apparent why the amino group is less well 'protected' in the former compound than in the latter.

Guided by these and other considerations, we began, some months ago, a study of the action of nitric acid on aniline and on aniline nitrate, and of the behavior of certain derivatives of aniline towards nitric acid alone and when mixed with acetic acid, oxalic acid, trichloracetic acid and sulphuric acid, respectively. The aniline derivatives employed included only those in which one or both of the hydrogen atoms of the amino group have been replaced, such as acetanilide, $C_6H_5NHCOCH_3$, or oxanilide,



A preliminary account of our work has recently appeared,[1] and we hope to publish further communications on the subject in the course of a few months. The object of this note is to call attention to certain of our results which we think may be of some general interest. Nitric acid of any concentration up to 75.33 per cent. when mixed with aniline in equimolecular proportion forms the nitrate, provided a suitable temperature is maintained, but the slightest excess of acid, if of comparatively high concentration, changes this colorless nitrate to a reddish pink compound. This may be kept for a day or two if it remains sufficiently cool, but, more or less quickly, depending on the temperature and on the excess of acid, it darkens, blackens and may become incandescent. The color is instantly discharged by a drop of water and is regenerated by more acid.

In the formation of mononitro derivatives of the substituted anilines referred to above, the position taken by the nitro group (ortho, meta, para) appears to depend on two factors: (*a*) the nature of this substituting group, *i. e.*, whether it be negative (acidic), positive (basic), or neutral; (*b*) the strength, not concentration, of the acid which has been mixed with the nitric acid. Should this conclusion be justified by our subsequent experiments, it will be seen that, as we can vary each of the above factors between very wide limits, the possibility is afforded of varying *a* in the same direction as *b* or in an opposite one, in order to prepare some desired isomer. Moreover, similar conditions might reasonably be expected to apply to the nitration of compounds in general, and if to nitration, then also, so far as experi-

[1] *Amer. Chem. Jour.*, **36**, 605 (1906).

mental conditions permit, to other similar reactions involving substitution.

We desire to call special attention to the discovery that acetic acid and sulphuric acid play a definite part in determining the position of the entering nitro group, because, heretofore, the belief has been quite general that when present with nitric acid the function of the sulphuric acid was confined to withdrawing from the sphere of activity the water formed during the process of nitration, while the acetic acid was regarded as a diluent to reduce the activity of the nitric acid. Oxalic acid and trichloracetic acid do not appear to have been previously employed in nitration experiments.

J. Bishop Tingle,
F. C. Blanck.

Johns Hopkins University,
November 24, 1906.

NOTES ON THE HISTORY OF NATURAL SCIENCE.

SIR JOHN MANDEVILLE.

To that dauntless literary freebooter of the fourteenth century who styled himself Sir John Mandeville, and whose 'Voiage and Travaile' enjoyed for a long time enormous popularity, very little consideration is given by historians of natural science. Yet this extraordinary compilation contains many matters of interest to the zoologist, botanist and even geologist of our day, to say nothing of its value from a purely literary or philological standpoint.

A fruitful theme for investigation has been an analysis of the sources, contemporary, early medieval and ancient, from which the narrator made wholesale robberies. Claiming to have been the traveling companion of Friar Odoric, the Bohemian (1286–1331), he appropriated bodily large portions of that noted traveler's itinerary, and precisely these portions are of chief interest to the naturalist. Concerning this question of sources, one may consult the splendid bilingual edition published by the Roxburghe Club, with notes by Mr. Warner, of the British Museum, and the valuable essay by Albert Bovenschen, published by the Berlin Geographical Society in 1888.

A point of interest to the geologist is Sir John's mention, in chapter 8, of the eruptive condition of Etna and the Lipari Isles. Very incomplete records have been preserved of early Liparian eruptions, and it would be interesting to find the statement confirmed by other writers that 'there be seven swelges that burn.' In the original French version this passage concludes: "Et de Ytaille iusques a ces volcans nad pluis de xxv. lieuez; et dit homme qe ces sunt chymenes denfern." This last remark is evidently a localization of a familiar legend, but whether original or not on the part of the author is hard to say. A parallelism exists, though I am not aware of any one having called attention to it, with one of the 'Dialogues' of St. Gregory, where the hermit of Lipari is described as having seen Theodoric the Great, on the day of his death, carried in bonds between Pope John and Symmachus, and thrown into the Volcano of Lipari. It was also a popular belief during the middle ages that Charles Martel had been banished within the crater of Stromboli.

Concerning the animal lore scattered throughout Sir John's book, it has been observed that "all the old legends of the Alexander saga and of the 'Miracles of the Orient'[1] are here amalgamated with much that is new about those fabulous monsters with which the medieval fancy populated the mysterious East." Yet besides these fables there is much authentic information of real value. A single point, of minor interest to be sure, is worth mentioning on account of its having engaged Cuvier's attention. A curious subversion of the Andromeda legend occurs in chapter 5 of Mandeville's book, where it is said that one of the ribs of the monster found at Joppa measured forty feet in length. The statement is evidently borrowed from Solinus (chapter 34), who obtained his information in turn from Pliny ('Nat. Hist.,' v. 14; ix., 4). According to the latter, the total length of the creature, whose bones were conveyed to Rome and exhibited there, was forty feet; and as shown by Cuvier, the description could not have applied to any other animal than a whale.

[1] References to the spread of this literature are given in Science, Vol. 23, p. 195.

Other instances of the stranding of whales are reported by the same classic author.

C. R. EASTMAN.

CURRENT NOTES ON METEOROLOGY.

LANTERN SLIDES FOR TEACHING METEOROLOGY.

THE Geographic Society of Chicago has done an excellent work for the development of meteorological instruction in the United States. It has collected a set of 270 lantern slides of various meteorological subjects. It has published a good descriptive text to accompany them. It sells the slides at cost. This is one of the more important meteorological contributions along educational lines which has been made in this country within the last few years. The plan was inaugurated in 1905 by Dr. J. Paul Goode, then president of the Chicago Geographic Society, and on the committee which was put in charge of the work were Dr. Goode, Professor Henry J. Cox, of the U. S. Weather Bureau in Chicago, the chief observer of the Weather Bureau in Chicago, and three teachers. The slides are copied from maps and diagrams in the *Atlas of Meteorology,* recent text-books, and in the *Monthly Weather Review;* from photographs, and from weather maps and weather records selected and prepared by the committee. A wide range of subjects is covered, and any teacher of meteorology, climatology or geography will surely find many slides suitable for use in his particular line of teaching. The text to accompany the slides embraces 130 pages. It includes a 'General Introduction,' by Professor Cox; a paper on 'The Use of the Lantern in Teaching Meteorology,' by Dr. Goode; a short working bibliography for the use of teachers, and then the descriptive text (110 pages). The latter is subdivided according to the subjects covered by the slides, including the following: weather observatories; meteorological instruments and instrument records; temperature distribution; atmospheric pressure and circulation; sunshine and other optical phenomena; humidity, cloudiness and precipitation; cyclones and anticyclones; thunderstorms and tornadoes; floods; synchronous weather conditions; life response to climate. This descriptive text is almost a small text-book in itself, and will be very helpful to teachers (unless perchance it be so complete that it tempts them to limit their reading to this alone). We welcome most heartily the Chicago Geographic Society's valuable contribution to meteorological education.

LAND AND SEA BREEZES ON THE GERMAN COAST.

THE phenomena of land and sea breezes on the eastern coast of Germany bordering the Baltic have been studied by Max Kaiser, of Halle ('Inaugural-Dissertation,' Halle, 1906), who has made use of anemograph records for the period 1901–5 at five stations extending over a strip of 300 miles of coast-line; of the observations taken thrice daily at storm-warning stations of the Deutsche Seewarte, and of observations on light-ships and on passing vessels. The sea breeze was found to begin at various times, often at 8 A.M. and often not until 2 P.M. or later. The absolute maximum velocity was 13.2 miles per hour; the absolute minimum was 0.8 miles per hour. The mean velocity is 4.5 to 6.7 miles per hour. April to September are the months of occurrence. Only those days were taken as sea-breeze days which had an offshore wind early, an onshore wind at noon and an offshore wind again in the evening. The 'roundabouts' which have been noted on the New England coast and in other places are but partially developed on the Baltic coast of Germany. An interesting study of the place of beginning of the sea breeze, based on observations from vessels offshore, makes a decided addition to our present knowledge on this subject. In the region under discussion the sea breeze, when conditions are favorable, begins between four and five nautical miles offshore, and the land breeze extends as far out as eight nautical miles.

MONTHLY WEATHER REVIEW.

No. 8, Vol. 34, 1906, of the *Monthly Weather Review* contains the following papers: 'The International Symbols,' by H. H. Clayton. It is pointed out that the American term 'frostwork' is equivalent to the German 'Rauhfrost,' and the English term 'silver thaw' is the equivalent of the Amer-

ican 'ice storm.' 'The Meteorological Optics of Professor J. M. Pernter' is a review of Pernter's standard work, recently published, by Professor R. W. Wood. 'The Meteorological Conditions Associated with the Cottage City Waterspout' (August, 1896), by Professor F. H. Bigelow. A full review and discussion of the weather conditions leads to the conclusion that a sheet of cold air, in front of an approaching anticyclone, overran the lower, warmer air, the cold air following at the surface a few hours later. This gave 'the exact conditions required to produce the observed powerful convection.' 'Variation in Temperature over a Limited Area,' by Professor W. I. Milham, of Williams College, embodies the results of studies at Williamstown, Mass., supplementary to those previously discussed in the *Monthly Weather Review* (July, 1905) by the same writer. 'Monthly Review of the Progress of Climatology throughout the World.' This is a comparatively recent addition to the regular contents of the *Review;* the notes are prepared by C. F. Talman, and will be found useful by teachers of meteorology and climatology. 'The First Daily Weather Map from China,' by the same writer, notes the publication of this new map on July 1, 1906.

CLIMATE OF FORT GRANT, ARIZONA.

We note the publication of a paper on 'The Climate of Fort Grant, Graham County, Arizona' in the *Journal of the Outdoor Life* for November. The writer is Dr. I. W. Brewer, and special attention is paid to the relations of this climate to disease.

R. DeC. Ward.

EVENING TECHNICAL COURSES AT COLUMBIA UNIVERSITY.

The Board of Extension Teaching of Columbia University announces a series of nine evening technical courses which will be given at the University this winter, beginning December 3, and lasting twenty weeks. The courses are under the immediate direction of Professor Walter Rautenstrauch, of the Faculty of Applied Science, and are to be given by professors and instructors of the university and other persons especially qualified. Moderate fees ($7.50 to $15) are charged and most of the courses are for two evenings a week. The courses are as follows:

Engineering Physics.—As illustrated in the mechanical plants of modern buildings. (1) An elementary study of physics: (2) a practical study of steam and electrical machinery, heating, ventilating, water system, wiring, elevators, etc., included in the plant of Columbia University. For two classes of students: those wishing an introductory study of physics as preparation to advanced study in electricity, steam, etc., another winter; those desiring practical training for positions as superintendents of buildings, engineers, janitors, etc.

Elementary Mathematics.—Those parts of arithmetic, algebra, geometry and trigonometry used in technical work. Practice with engineering hand-books, tables, etc.

Drafting.—A beginner's course; fits for positions as draftsmen; reading of drawings, etc.

Strength of Materials.—A lecture course for those who design or manufacture machinery, or modern structures. With this course should be taken either the first or second of the two following courses in design.

Machine Design.—Advanced drafting, computations, and designing for persons engaged in the design and manufacture of machinery.

Structural Design.—Advanced drafting, computations, and designing for those who do structural work.

Electrical Engineering.—A course especially for those engaged in electrical work of any sort.

Steam Engineering.—A course for those engaged in the manufacture or management of steam machinery of any sort.

Special Engineering Problems.—A study of any special elementary or advanced engineering problems desired by the student: Individual instruction will be arranged for such a period of time as the special problem may demand.

The courses will be given in the buildings of Teachers College, Columbia University, at West 120th Street and Broadway, which affords necessary lecture rooms, laboratories, drafting rooms, etc. A complete catalogue of these courses will be sent on request, by addressing Evening Technical Courses, Extension Teaching, Columbia University. Personal information may be secured on Tuesday

and Thursday evenings, between 7:30 and 9 o'clock from Mr. Benjamin R. Andrews, Room 111, Teachers College.

PROFESSOR OSBORN AND THE SECRETARYSHIP OF THE SMITHSONIAN INSTITUTION.

PROFESSOR HENRY FAIRFIELD OSBORN has declined the secretaryship of the Smithsonian Institution, to which he was elected by the regents on December 4. His letter to Hon. Melville W. Fuller, chancelor of the Smithsonian Institution, dated New York, December 11, contains a full statement of all the reasons which, after reconsideration, finally render Professor Osborn unable to accept the post of secretary. Chief among these reasons is the fact that he is nearing the completion of several monographs and books, the prosecution of which is dependent upon the collections which he has brought together in New York and the staff of trained assistants who are working with him. Among these works especially is the 'History of the Tertiary or Fossil Mammals of North America,' the 'Titanothere Monograph' and the 'Sauropoda Monograph' for the United States Geological Survey, which were begun by the late Professor O. C. Marsh, a monograph on the evolution of the horse in preparation for the American Museum of Natural History series, also a popular volume on the evolution of the horse to be published by Columbia University, in addition to a large number of minor or supplementary papers and researches. The main tenor of Professor Osborn's letter is shown in the following abstract:

I was absolutely taken by surprise and deeply moved by your generous action in voting to elect me to the most honorable post of Secretary of the Smithsonian Institution. It is the greatest honor I have received or expect to receive; yet after several days which I have devoted almost exclusively to reflection on this matter from every standpoint, I find myself unable to accept your invitation.

I desire to explain to you fully why I have reached this conclusion, and I trust I may be able to convince you it is through no lack of the sense of public duty which should inspire every American. I hope I may convince you also that acceptance would involve a change of career just at a time when I am trying to publish the results of thirty years of research. These results would have been partly or entirely in print at this time had it not been that for the past sixteen years I have been interrupted and drawn away by executive and administrative work of the *very* character which would be demanded of your new secretary on a grander scale. The possibility of *continuing and completing these researches and at the same time serving the office as it should be served* is the point on which my attention has been centered during the past few days.

As to *time for research*, my friend Dr. Alexander Graham Bell in the course of two conferences has assured me that the Regents especially desire an investigator as well as an administrator; in other words, that the secretary should continue his scientific researches, whatever they may happen to be, and I have tried to convince myself that even with my peculiar temperament I might be able to withdraw from time to time to pursue and complete these publications. On this point I have chiefly reflected, reviewing my experience here in far less responsible positions. Naturally there is some strong pressure here against my acceptance of the post; but to reach an impartial conclusion I have listened chiefly to those who *desire to see me accept*. In these conferences and among the numerous letters of congratulation which I have received from scientific workers in all parts of the country, I have not found one to hold out the hope or expectation that my scientific researches will continue even as they have in the past. I am myself convinced that even with the assured cooperation of a very able staff, the ideal development of the Smithsonian with all its auxiliary institutions will require nothing less than the entire time, thought, energy, and strength of the secretary for four or five years to come. The quiet days of Joseph Henry and even of Spencer F. Baird in this country have passed. The enormous growth of the country, the telephone, the telegraph, the wireless, the great newspaper, make the seclusion and quiet absolutely essential for research increasingly difficult every day.

Failure in the post or anything short of complete success would disappoint you and would disappoint the public, who naturally cannot appreciate the undisturbed conditions essential to the prosecution of successful intellectual work. Other men may be so constituted as to assume a grand office like the secretaryship, with its splendid possibilities for the future, and not have it

on their minds day and night; unfortunately perhaps, I am not so constituted.

The matter of *materials* for the completion of my work presents a still more serious difficulty, because palæontology differs substantially from many other branches of zoology. We have here the finest palæontological collection in existence, as the result of sixteen years of exploration and purchase, a staff of over twenty highly trained assistants, preparators, field workers and artists, all harmoniously working toward a common end. The opportunity could not be recreated in Washington because it is in a branch of pure science which least of all bears upon human welfare and happiness and is, moreover, extremely expensive. As secretary of the Smithsonian I could not conscientiously recommend the annual appropriation of $25,000 to $30,000, to this branch, and I know I should not have the support of Congress for other more vital subjects if I did. In other words, a change of residence would cut me off from my materials of research.

In brief, I have finally and for many reasons very regretfully reached the conclusion that the secretaryship would mean a change of career, just at the moment when I feel that without selfishness I am on the point of bringing out the results of many years' labor. I trust that these results are really important, that they will tend to advance American science, and that they will inspire younger men to broad and thorough standards and to strive for absolute truth rather than for brilliant and short-lived generalizations.

I hope I have been able in this long letter to win you over to the point of view which I have reached after most conscientious reconsideration of this matter, and that I shall retain the confidence and esteem which prompted you to vote for me, which I value far more highly than I can possibly express. May I beg also that you will make it generally understood that I am clearly unable to reach any other decision.

PRELIMINARY PROGRAM OF THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND THE AFFILIATED SCIENTIFIC SOCIETIES.[1]

Wednesday, December 26.

Registration.—Hotel Belmont, opposite the Grand Central Station, W. 42d Street.

Executive committee of the council of the American Association. Hotel Belmont, noon.

Smokers. Hotel Belmont and Murray Hill Hotel, 8:30 P.M.

Thursday, December 27.

Registration. Earl Hall, Columbia University (Broadway, Amsterdam Avenue and 116th St.). To be reached by subway express trains on Broadway from the hotel headquarters and railway terminals.

Council of the American Association. Trustees Room, Library, Columbia University, 9 A.M.

General session. Introduction of the president of the meeting, Dr. William H. Welch, Johns Hopkins University, by the retiring president, Dr. C. M. Woodward, Washington University. Welcome by President Butler, Columbia University. Announcements. Earl Hall, 10 A.M.

Organization of Sections.—Addresses of Vice-president F. W. McNair in mechanical science and engineering; Vice-president George Grant MacCurdy on 'Some Phases of Prehistoric Archeology.' Programs of Sections.—The sections will meet as follows: Mathematics and Astronomy, 506 Fayerweather Hall; Physics, 301 Fayerweather; Chemistry, 309 Havemyer; Mechanical Science and Engineering, 302 Engineering; Geology and Geography, 305 Schermerhorn; Zoology, 618 Schermerhorn; Botany, 502 Schermerhorn; Anthropology, 306 Mines; Social and Economic Science, 301 Engineering; Physiology and Experimental Medicine, College of Physicians and Surgeons, West 59th Street. These meetings will be held at 11 o'clock, following the adjournment of the general session.

Luncheon. University Commons, Columbia University—table d'hote, 30 cents, à la carte, 5 cents and upwards, 12 to 2 P.M.

Address of Vice-president W. S. Eichelberger, of the U. S. Naval Observatory, before the Section of Mathematics and Astronomy. Vice-president C. F. Mabery, Case School of Applied Science, on 'The Education of the Professional Chemist.' Vice-president William North Rice, Wesleyan University, on 'The Contributions of America to Geology.' Vice-president Henry B. Ward, University of Nebraska, on 'The Influence of Parasitism on the Host.' Vice-president Wm. T. Sedgwick on 'The Expansion of Physiology.' These addresses will be given at 2:30 P.M.

[1] This program contains only certain of the main features of the meeting. Members should secure the program of the American Association, which will be distributed at Earl Hall on December 27, and the programs of the special societies in which they are interested.

Programs of the sections and societies in their respective rooms, in the main as given above, 2 or 2:30 P.M.

Section of Physiology and Experimental Medicine. Discussion on 'Protozoa as Factors in the Diseases of Animals and Plants.' College of Physicians and Surgeons, 3:30 P.M.

Meeting of the council of the American Chemical Society, 3:30 P.M.

Address of the retiring president of the American Association, Dr. C. M. Woodward, on 'Science in Education,' Horace Mann Hall, Teachers College, Columbia University (Broadway and 120th Street), 8 P.M.

Reception by the president of Columbia University. Earl Hall, 9 to 11 P.M.

Smoker. Faculty Club, Columbia University, 9.30 P.M.

Friday, December 28.

Registration, validation of railway tickets, etc. Earl Hall.

Council of the American Association. Trustees room, 9 A.M.

Meetings of the sections and societies in their respective rooms, 10 A.M. and earlier.

Joint meeting of the Section of Mathematics and Astronomy, the American Mathematical Society, the Astronomical and Astrophysical Society of America. Room 405, Schermerhorn Hall, 10 A.M.

Joint meeting of the Section of Physiology and Experimental Medicine and the American Bacteriological Society. Rockefeller Institute for Experimental Medicine (66th Street and Avenue A), 10 A.M.

Geological Society of America. American Museum of Natural History, 10 A.M.

Luncheon, 12 to 2 P.M.

Luncheon. The Schultz Mineral Water Company (440 First Avenue), for the American Chemical Society and Section C, followed by excursions.

Address of Vice-president Henry Crew, Northwestern University, on 'Fact and theory in Spectroscopy.' Vice-president Erwin F. Smith, U. S. Department of Agriculture, on 'Problems of Plant Physiology.' Vice-president Irving Fisher, Yale University, before the Section of Social and Economic Science, 2:30 P.M.

The sections and societies will meet at 2 or 2:30 P.M. in their respective rooms.

Meeting of the American Society of Naturalists. 305 Schermerhorn Hall, 2:30 P.M., followed by a discussion at 3:30 on 'The Biological Significance and Control of Sex,' by Dr. A. F. Blakeslee, Harvard University; Professor F. R. Lillie, University of Chicago; W. T. Swingle, U. S. Department of Agriculture; Professor E. B. Wilson, Columbia University; Professor R. A. Harper, University of Wisconsin; Professor T. H. Morgan, Columbia University; J. B. Nichols, Washington.

Address by President William James before the American Philosophical Association on 'Surplus Stores of Energy.'

Dinners. The American Society of Naturalists. University Commons, Columbia University. The American Chemical Society, the American Geological Society of America and other societies and groups, places to be designated, 6:30 or later.

Address of Vice-president Davenport, on 'Cooperation in Science,' before the American Society of Naturalists. 8 P.M.

Smoker of the American Society of Naturalists. Faculty Club, 9 P.M. Other smokers and informal meetings have also been arranged.

Saturday, December 29.

Registration, etc. Earl Hall.

Council of the American Association. Trustees room, 9 A.M.

Meetings of the societies and sections. 10 A.M. and earlier.

Botanical Society of America. Botanical Garden, morning and afternoon.

Addresses. Professor C. F. Chandler, Columbia University, on 'The Electrical Industries of Niagara Falls.' Dr. John M. Clarke, of the Science Division, New York State Educational Department, on 'The Effort to Save Niagara.' Townsend Harris Hall, City College (138th Street and Amsterdam Avenue), 12 o'clock, followed by a complimentary luncheon in the gymnasium and an inspection of the new buildings.

Unveiling of ten marble busts of American men of science with addresses. American Museum of Natural History, 3 P.M.

Reception by the trustees of the American Museum of Natural History and the council of the New York Academy of Sciences; exhibit of scientific progress by the New York Academy of Sciences with demonstrations and short addresses. American Museum of Natural History, 8 P.M. The exhibit will also be open on Friday afternoon and evening and on Saturday afternoon.

Address of the president of the American Chemical Society, Dr. W. F. Hillebrand, U. S. Geological Survey, on 'The Present and Future of the American Chemical Society,' Chemists Club (108 West 55th Street), 8 P.M.

Smoker. Chemists Club, 9 P.M.

Monday, December 31.

Registration, etc. Earl Hall.

Council of the American Association. Trustees room, Columbia University, 9 A.M.

Meetings of the sections and societies, 10 A.M. or earlier; 2:30 P.M. or earlier.

Luncheon, 12 to 2 P.M.

Complimentary dinner to the President of the Association by men of science of New York City. University Club, 7:30 P.M.

Banquet of Sigma Xi. Place and time to be designated.

Nominating Committee. Hotel Belmont, 9:30 P.M.

Tuesday, January 1.

Registration, etc. Earl Hall.

Council of the American Association. Trustees room, Columbia University, 9 A.M.

General session. Earl Hall, 10 A.M.

Meetings of the sections and societies, 10 A.M. or earlier; 2:30 P.M., or earlier.

Luncheon. 12 to 2 P.M.

The societies that will meet in New York City in convocation week and their officers are as follows:

American Association for the Advancement of Science.—December 27–January 1. Retiring president, Professor C. M. Woodward, Washington University, St. Louis, Mo.; president-elect, Professor W. H. Welch, The Johns Hopkins University, Baltimore, Md.; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Dr. John F. Hayford, U. S. Coast and Geodetic Survey, Washington, D. C.; secretary of the council, President F. W. McNair, Houghton, Mich.

Local Executive Committee.—J. J. Stevenson, chairman; C. C. Adams, Charles Baskerville, Franz Boas, N. L. Britton, H. C. Bumpus, Chas. A. Conant, Simon Flexner, Wm. J. Gies, Wm. Hallock, Alex. C. Humphreys, G. S. Huntington, Edward Kasner, Henry F. Osborn, C. L. Poor, Clifford Richardson, E. B. Wilson, Frederick J. E. Woodbridge, J. McKeen Cattell, secretary.

Section A, Mathematics and Astronomy.—Vice-president, Professor Edward Kasner, Columbia University; secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor W. C. Sabine, Harvard University; secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Mr. Clifford Richardson, New York City; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Mr. W. R. Warner, Cleveland, O.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Dr. A. C. Lane, Lansing, Mich.; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Professor E. G. Conklin, University of Pennsylvania; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president, Dr. D. T. MacDougal, Washington, D. C.; secretary, Professor F. E. Lloyd, Desert Botanical Laboratory, Tucson, Arizona.

Section H, Anthropology.—Vice-president, Professor Hugo Münsterberg, Harvard University; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Mr. Chas. A. Conant, New York City; secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Dr. Simon Flexner, The Rockefeller Institute for Medical Research; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

The American Society of Naturalists.—December 28. President, Professor William James, Harvard University; secretary, Professor W. E. Castle, Harvard University.

The Astronomical and Astrophysical Society of America.—December 27. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—President, Professor Carl Barus, Brown University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Mathematical Society.—December 28, 29. President, Professor W. F. Osgood, Harvard University; secretary, Professor F. N. Cole, Columbia University.

The American Chemical Society.—December 27–January 2. President, Professor W. F. Hillebrand, U. S. Geological Survey; secretary, Dr. William A. Noyes, the Bureau of Standards, Washington, D. C.

The Geological Society of America.—December 26–29. Acting president, Professor W. M. Davis, Harvard University; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

The Association of American Geographers.—December 31–January 1. President, Cyrus C. Adams, New York City; secretary, Albert P. Brigham, Colgate University.

The American Society of Zoologists.—December 27, 28, 29. President (Eastern Branch), Professor W. E. Castle, Harvard University; secretary, Professor H. S. Pratt, Haverford College. President (Central Branch), Professor C. C. Nutting, University of Iowa; secretary, Professor T. G. See, University of Michigan.

The Association of Economic Entomologists.—December 28, 29. President, A. H. Kirkland, Malden, Mass.; secretary, A. F. Burgess, Columbus, O.

The Society of American Bacteriologists.—President, Dr. E. F. Smith, U. S. Department of Agriculture; secretary, Professor S. C. Prescott, Massachusetts Institute of Technology.

The American Physiological Society.—December 27, 28, 29. President, Professor W. H. Howell, the Johns Hopkins University; secretary, Professor Lafayette B. Mendel, 18 Trumbull St., New Haven, Conn.

The Association of American Anatomists.—December 27, 28, 29. President, Professor Franklin P. Mall; secretary, Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

The Botanical Society of America.—December 27, 28, 29. President, Dr. F. S. Earle; secretary, Dr. William Trelease, Missouri Botanical Garden, St. Louis, Mo.

The American Psychological Association.—December 27–28. President, Professor James R. Angell, University of Chicago; secretary, Professor Wm. Harper Davis, Lehigh University.

The American Philosophical Association.—December 27–29. President, Professor William James, Harvard University; secretary, Professor John Grier Hibben, Princeton University.

The American Anthropological Association.—December 27–January 3. President, Professor F. W. Putnam, Harvard University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—December 27–January 3. President, Dr. A. L. Kroeber, University of California; secretary, W. W. Newell, Cambridge, Mass.

New York State Science Teachers Association.—December 26, 27. President, John F. Woodhull, Teachers College, Columbia University.

All railways have granted a rate of one and one third fare for the round trip to those attending the meeting. Certificates should be obtained for the meeting of the American Association for the Advancement of Science.

SCIENTIFIC NOTES AND NEWS.

DR. WILLIAM H. WELCH, professor of pathology in the Johns Hopkins University, and Dr. Henry S. Pritchett, president of the Carnegie Foundation, have been elected trustees of the Carnegie Institution.

THE New York Academy of Sciences held its annual meeting on December 17. Following the dinner Dr. N. L. Britton, director of the New York Botanical Garden, gave the presidential address. The officers for next year are as follows:

President: Nathaniel L. Britton.

Vice-Presidents: Section of Biology, H. E. Crampton; Section of Geology and Mineralogy, Amadeus W. Grabau; Section of Astronomy, Physics and Chemistry, Charles C. Trowbridge; Section of Anthropology and Psychology, Robert MacDougall.

Corresponding Secretary: Richard E. Dodge.

Recording Secretary: Edmund Otis Hovey.

Treasurer: Emerson McMillin.

Librarian: Ralph W. Tower.

Editor: Chas. Lane Poor.

Councilors: To serve three years, William M. Wheeler, Charles Baskerville.

Finance Committee: John H. Caswell, George F. Kunz, Frederic S. Lee.

PROFESSOR T. W. RICHARDS has been elected an honorary member of the Royal Institution of Great Britain.

MR. ALEXANDER AGASSIZ has chartered the steam yacht *Virginia* for a cruise to the West Indies. The yacht will sail from New York the first week in February to be absent for three months.

PROFESSOR RICHARD E. DODGE, of Teachers College, Columbia University, has been made an honorary member of the Royal Geographical Society of Australasia. He will contribute a paper on 'The Geographer and School Geography' to the twenty-first anniversary meeting, at Queensland.

The Journal of the American Medical Association states that the fact that the Nobel prize this year has been awarded to Cajal and Golgi has roused their compatriots to do them

exceptional honor. It has been proposed that one street in Madrid and one in Pavia be named after Cajal and Golgi, respectively, and the name of Golgi is to be given to one of the hospitals of Pavia. Various other projects also are being discussed. It is reported that Cajal may be knighted and made a senator for life and that endowed prizes may be given in his name.

Professor John R. S. Sterrett, of Cornell University, sailed on December 15 for Athens with a party which will spend two years in archeological field work in the near east.

Mr. William E. D. Scott, curator of ornithology at Princeton University and director of the Worthington Society for the Investigation of Bird Life, is spending the winter at Trudeau, New York, in the interest of his health, on a six months' leave of absence from the laboratory of the Worthington Society at Shawnee, Pennsylvania.

Professor G. W. A. Luckey, of the department of education of the University of Nebraska, has been given a leave of absence for the next semester to allow him to go abroad to study secondary education in European countries.

Dr. R. S. Woodward, president of the Carnegie Institution, gave an address on 'Technical Education' at the meeting of the Washington Society of the Massachusetts Institute of Technology on December 12.

Dr. William R. Brooks, director of the Smith Observatory and professor of astronomy at Hobart College, Geneva, N. Y., delivered two illustrated astronomical lectures recently before the Franklin Institute, Philadelphia. The subjects were 'Other Worlds than Ours' and 'The Evening and Morning Stars.'

Sir Victor Horsley's Hughlings Jackson lecture before the Neurological Society of the United Kingdom on November 29 was entitled 'The Illustration by Recent Research of Dr. Hughlings Jackson's Views on the Functions of the Cerebellum.'

On December 12, 1906, in the chapel of the University of Nashville, a portrait of Gerard Troost was unveiled with appropriate ceremonies. Troost was the pioneer geologist of the state of Tennessee, was state geologist from 1831 to 1850, and was professor of geology, mineralogy and chemistry in the University of Nashville from 1828 to the time of his death in 1850. Addresses were made by James D. Porter, LL.D., chancellor of the university; J. I. D. Hinds, Ph.D., LL.D., professor of chemistry, and P. H. Manning, A.M., professor of geology. The geological building and the cabinet which it contains have also been named in honor of Gerard Troost.

A statue of the late Principal Viriamu Jones, F.R.S., first principal of the University College of South Wales and Monmouthshire and the first senior vice-chancellor of the University of Wales, was unveiled at Cardiff on December 1 by Viscount Tredegar. The statue, which is the work of Mr. Goscombe John, A.R.A., has been placed temporarily in the new city hall, but will be removed to the new college buildings when they are completed.

Mr. Arthur Vaughan Abbott, a well-known electrical engineer in New York City, author of important works on telephony and electrical transmission of energy, has died from pneumonia at the age of fifty-two years.

Fitzhugh Townsend, A.B., E.E., instructor in electrical engineering at Columbia University, died of typhoid fever on December 11, at the age of thirty-four years.

Sir Edward J. Reed, F.R.S., chief constructor of the British navy from 1863 to 1870 and later lord of the treasury and member of parliament, died on November 30, aged seventy-six years.

The Central Branch of the American Society of Naturalists and Affiliated Societies will hold its next annual meeting during the Easter vacation, at the University of Wisconsin. There will consequently be no conflict with the convocation week meeting in New York City.

The following lectures will be given during the winter by Lewis M. Haupt, Sc.D., professor of civil engineering of the Franklin Institute, Philadelphia. 'The Chesapeake and

Delaware Canal as the Keystone of the Coastwise System,' before the Franklin Institute, December. 'The Relation of the Government to its Waterways,' at the Carnegie Institute, Pittsburg, January 10, to be followed by an address to the Pittsburg Board of Trade on the 'Railroad Crisis' on the next evening, January 11. The Connecticut Society of Civil Engineers will entertain Professor Haupt at its annual banquet on February 12 (Lincoln's birthday), when it will hear his address on 'Transportation Economics.' On Washington's birthday he will address the students of the Sheffield Scientific School at New Haven on 'Commercial Waterways and their Economics.' The College of Engineering of Cornell University has in view a lecture on the 'Isthmian Canals' at a date to be determined.

AT the anniversary meeting of the Royal Society it was announced that in May last the council learned that the funds (£36,000) provided by the British South Africa Company for the South African meridian arc had been exhausted. The arc had been extended beyond the Zambezi towards Lake Tanganyika, but a gap of 120 miles existed in the middle of it. It was estimated that £1,600 was required to fill this gap, and the matter was most urgent in view of the pending disbandment of the surveying parties. The officers had intimated by authority from the president that the Royal Society would probably be able to subscribe £300 from its private funds on condition that the remainder of the money required were provided; and, on the strength of this information, Sir G. Darwin obtained a promise of £800 from the British South Africa Company, £100 from the Royal Geographical Society, £100 from Wernher, Beit and Co., and cabled to Sir David Gill that the surveying party was to proceed, thus assuming responsibility for the remaining £300. This £300 has since been subscribed by the British Association from its special South African fund.

WE learn from the London *Times* that what is probably the largest male mandrill (*Papio mormon*) ever received at the London Zoological Gardens has just been deposited, and will be exhibited in the open-air cage at the west end of the monkey-house. At present it is in temporary quarters in a stout traveling cage on the green at the back of the anthropoid house. Lest unwary visitors should be tempted to overstep the low railing and feed the mandrill, the cage bears a label, 'This animal is dangerous.' This baboon, native in West Africa, from Senegambia to the Congo, presents a remarkable appearance from its ungainly form and strange coloration. Its body is stoutly built, with short powerful limbs and massive head sloping from the occiput to the muzzle; the ears are small and triangular, and the large circular nostrils pig-like in having a raised border. No other baboon shows such striking color contrasts; the fur is blackish olive, the nose red, and on each side of the face are large transverse sausage-shaped swellings of a light blue tint with the grooves between them deep purple; the beard is citron yellow, and the seat pads are scarlet. No large mandrill has been exhibited in the gardens for nearly thirty years; in 1878 a female in the collection produced a hybrid young one to a male macaque (*Macacus cynomolgus*). A young Kashmir stag (*Cervus cashmirianus*) has been presented by the Duke of Bedford, from the herd at Woburn, and placed in the deer sheds. Only once before has the species been representd in the collection, and from the official catalogue that appears to have been so long ago as 1865. This deer is somewhat larger than the red deer; dark reddish brown above, lighter beneath and the rump patch dirty white. There is no cup in the antlers, and the tines on each side are normally five, though eight have been noted in Mr. Rowland Ward's 'Records of Big Game.' In the pairing season old stags squeal like wapiti instead of roaring like red deer, and the spotting in the fawns persists much longer than it does in fawns of the last-named species. Captain Pam has once more presented a fine collection of South American birds, principally tanagers and finches, most of which are now on view in the insect-house. The only species determined as new to the

collection is a green toucan (*Aulacorhamphus sulcatus*), though a grosbeak and two siskins remain to be identified.

UNIVERSITY AND EDUCATIONAL NEWS.

ANNOUNCEMENT has been made by President Charles F. Thwing that gifts of $100,000 each have been made to Western Reserve University, Cleveland, O., by Mr. H. M. Hanna and Colonel Oliver H. Payne. The $200,000 thus subscribed is to be used in establishing and endowing a laboratory of experimental medicine in the medical school. A professorship of experimental medicine has been created and Professor George N. Stewart, of the University of Chicago, has been elected to the chair, the first of its kind, it is said, to be created in this country.

THE trustees of Hobart College have accepted the proposition of Mr. William Smith, of Geneva, N. Y., to found a woman's college. The name of the new college will be the William Smith College for Women, and it will have an endowment of about $350,000. The new college will have five members on the board of trustees, two of whom must be women. Two new buildings will be erected, a dormitory and a biological and psychological laboratory, to be known as the William Smith Hall of Science.

MR. JOHN D. ROCKEFELLER has sent word to the Board of Foreign Missions of the United Presbyterian Church that he will give $100,000 toward educational work in Egypt and the Soudan.

A 'CARL SCHURZ memorial professorship' is to be established at the University of Wisconsin as a result of the movement recently started in Milwaukee by a number of prominent German-Americans. The plan is to raise an endowment of $50,000, the income of which will be used for the establishment of an annual course of lectures at the state university, to be given by prominent professors of German universities. It is hoped that the establishment of this new chair will lead to an exchange of professors between the University of Wisconsin and German universities.

PRESIDENT PLASS, of Washburn College, Topeka, Kans., a congregational institution, has announced that Mr. Andrew Carnegie has offered to give the college a second $50,000 for its endowment fund, provided the total endowment reaches $200,000 by January 1, 1908.

ACCORDING to a cablegram from Tokio members of the Furukawa family, who are prominent Japanese mine owners, have given 1,000,000 yen (about $500,000) to establish the nucleus of new universities at Fukuoka, Sapporo and Sendai.

As a result of Bishop O'Connell's mission to Japan the Vatican will establish shortly a Catholic University at Tokio. It will be controlled by Jesuits of the American province.

DR. A. LAWRENCE ROTCH, the founder and director of the Blue Hill Meteorological Observatory, has been elected professor of meteorology at Harvard University.

DR. A. E. HALSTEAD has been elected professor of surgery in the Northwestern University Medical School.

AT the annual meeting of the trustees of Oberlin College on December 5 it was voted that under the provisions of the Carnegie Foundation retirement is to be at the option of the teacher or college at the age of sixty-five, but obligatory at sixty-eight. The office of dean of the college of arts and sciences was created, and Charles E. St. John, professor of physics, was elected to the office. Mr. Earl F. Adams, now at Harvard University on leave of absence, was made associate principal and associate professor of physics in the academy. Dean Edward T. Bosworth was granted leave of absence for the second semester. Two associate professorships were created, one in English and one in political science. The bids for the new library exceed the $125,000 given by Mr. Carnegie. After some modifications in the plans bids will be obtained again.

MR. F. J. DYKES, M.A., fellow of Trinity College, Cambridge, late lecturer in mechanics at the Royal Naval College, Portsmouth, has been appointed lecturer in mechanics at Trinity College.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 28, 1906.

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ADDRESS OF THE PRESIDENT OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.[1]

THE SCIENCE OF EDUCATION.

THE record of the year 1906 exhibits so many kinds and degrees of progress; such evidence of improvement in national and international well-being; such a development of the arts of peace in all lands; such exhibitions of zeal, individual and social, in behalf of corporate and governmental integrity; such abundant industrial and commercial prosperity; and finally such a universal tendency to promote education, to advance science and to foster higher standards of civilization—in short, the year just past is so full of noble endeavor, and endeavor crowned with success, that I stand almost mute in the presence of what ought to be said of the advancement of science, as science grows from more to more, and more and more is applied to the myriad arts of life.

I agree heartily with Huxley and others that there is no valid distinction between pure science and applied science. The final test of the value of what is called science is its applicability, and it is one of the signal triumphs of the last few years that much of what was rated as 'pure science,' and 'pure' because useless, has proved to be invaluable either in widening the boundaries of scientific attainment, or in the development of the useful arts.

All genuine science should be both pure and applied. In a word, let the purity and the application be taken for granted; and

[1] New York meeting, December, 1906.

let every man who finds in the formula of the mathematician, or in the formula of the chemist, or in the formula of the biologist, the key which unlocks the storehouse of nature's secrets; solves a hitherto unsolved problem of matter; or throws light upon one of the hard questions of vegetable or animal life, still claim that his science is pure, when science enables us to invent a new prime mover, to produce a new material of construction, or create a new article of food, let us give credit where credit is due—to science, and to associations which aim to advance all true science and which foster every effort to make that science useful to mankind.

The false, though inherited, notion that polite learning and true culture admit no contact with utility, is, thank Heaven, fast dying out. Occasionally a voice from the 'inner circle' shouts gleefully: "Here's to mathematics! May she never be prostituted to any human use!" But we can afford to smile at the conceit of such a Levite of culture, and pity him for his narrowness and lack of human sympathy. However, those 'pure' scientists often build better than they know. Even the professor who boasted that he had never wittingly either learned or taught anything useful has become the servant of real learning by extending the limits of scientific knowledge, which refuses to be hindered or circumscribed by its mistaken votaries.

There is, as every careful observer can testify, an abundance of useful fruit in every department of scientific research. Note the uses of electricity, chemistry and thermodynamics; of botany in fruit culture; of bacteriology in the warfare for human and animal health; and how the discoveries of science in a hundred fields is made useful in inventions for the transformation, transmission and utilization of energy.

It is not my purpose to point out the progress made during the past year in the discovery of scientific truths, and in their utilization in the various directions indicated by the different sections of this association. The task would be too great for me or for any one man. The printed reports and proceedings of the sections themselves will furnish the best permanent record. It is, however, my purpose to call the attention of the association to the importance of the science and art of education, and to suggest the propriety of creating a new section devoted to the advancement of the science of education.

THE SCIENCE OF GOOD GOVERNMENT.

Before taking up the subject which, for fifty years, has been more or less directly my life and my delight, I desire to express my estimate of the unparalleled achievement of our national government in the interests of peace and international brotherhood. I refer, of course, to our intervention, in accordance with our contract, with Cuba, to restore and maintain peace, order and good government in that long-suffering and badly-educated island. Never before, in the history of the world, did a strong nation go with an army and navy to the aid of a weak and inexperienced nationality when it was torn into factions by jealousies and distrust so deep and bitter as to overcome their desire for good order and self-government; and then, without firing a shot or taking a prisoner, establish order, disarm hostile bands, promote mutual confidence and restore the occupations of peace; and finally, having accomplished this remarkable feat, our army and navy came home again, with no booty, with no trophies, with no captives, with no triumphal procession—with nothing but the consciousness of having done an act of international good-will. The spectacle is one for the world to look upon and admire.

There is most surely a science of good government, and that science we, as a people, are rapidly advancing in this western world.

Let no one try to take away from the essential nobility of this act by pointing to the interest of a few American planters in Cuba. We are glad to have their interests protected, but those interests were relatively unimportant, and I firmly believe that had there not been an American planter or merchant in Cuba, our government's course of action would have been just the same, with the same splendid result. So let not the glory of this transaction be dimmed by unworthy detractions or by neglect. It was a great and noble work two years ago to prevail upon Russia and Japan—when those two nations stood face to face, each with an army of half a million men, ready to crush and slay till the blood of a hundred thousand young men should again stain the soil of Manchuria—to stop fighting, to withdraw their forces, and to submit the issues of their quarrel to a council of peace. That was a great work, and we glory in its accomplishment—but the work done in Cuba is not less fine, though less spectacular. Its modesty, its example of purity and restraint, of justice and respect for law, its vindication of the principles and duties of a republic—all combine to make this year of our Lord 1906 an epoch in international courtesy if not in international law.

EDUCATION IN THE ARTS OF PEACE VS. EDUCATION IN THE ARTS OF WAR.

One word more of immediate interest. The great exposition at St. Louis, in 1904, gave an epitome of the civilizations of all the nations and tribes of the earth. Their representatives dwelt or camped side by side and exhibited with marvelous fidelity and fullness their industries, their commerce, their science, their art, their systems of education and their modes of life. It was, indeed, a great educational institute carried on for seven months in the presence of millions of visitors from every nation under the sun. Probably no human instrumentality was ever more potent in promoting the advancement of science than that exposition. The great congress brought together the best of living men, and they offered their best tributes for the service of science and human progress, and we had the supreme spectacle of the triumphs of the arts of peace.

The exhibit of instruments designed to kill human beings, and of appliances for the destruction of ships and forts, was minimized, and the pageantry of war offered few attractions and claimed small attention. The glory of the exposition was its devotion to education, and the application of science to the useful arts.

I have thus characterized the exposition of 1904, in order to show more clearly what I consider an unfortunate tendency on the part of the management of the proposed Jamestown Exposition at Norfolk, Va., in 1907. I refer to the prominence which military and naval exhibits and evolutions occupy in the prospectus of attractions. The emphasis would seem to be on the science and the art of war, as though the glory of our American manhood lay in our ability to overawe, crush and destroy the very peoples who, two and a half years ago, joined hands with us and with each other in fostering the growth of an international brotherhood which should relegate the waste and horror of war to the pages of history.

Are we not in danger of cultivating overmuch a warlike attitude and of encouraging the growth of a taste for warfare? The maxim, 'In time of peace, prepare for war,' has done infinite mischief. It has misled statesmen, and sent millions upon millions of young men to untimely graves.

It means arsenals and forts, great standing armies and vast fleets of battleships; and yet those are the very things we wish to reduce to the lowest possible terms. I approve of a single military academy and a single naval academy, since both are needed by a modest army and navy; but I do not wish to see military academies multiply, nor would I have the mimicry of war become a pastime in our schools. I doubt if a correct science of education will include the science of shooting our fellow men. The episode of the early Jamestown was not a military campaign nor a naval victory; it was rather a step in the conquest of nature, and a chapter in human progress. I trust it is not too late to give to the Jamestown Exposition a tone less warlike, and to put the emphasis where it must in future belong, upon education, science, industry, commerce and social progress.

EDUCATIONAL THEORIES, ANCIENT AND MODERN.

Coming now to the special message of this address, I propose for your serious consideration the organization of an additional section devoted to the 'science of education.'

As one looks over the history of education he is struck by its chaotic condition. From Aristotle to the men now living, we find the problem of Education discussed from many points of view, with many different objects in mind, and under widely different social conditions.

The Greek idea of education and culture was based upon the existence of a privileged class, fed, clothed and sheltered by the labor of slaves—a real aristocracy devoted to war, art, literature and luxurious living. The sway of the so-called classic idea of education has been and still is one of the marvels of history. The splendor of Greek art, the brilliancy of Greek literature and the keenness of Greek logic have held the world as in a trance, unable to break away from its charms—though it has been unsuited to other peoples and other social conditions.

I need not turn the pages of history to name the writers and teachers who have risen in protest or set forth new doctrines. In many cases the new prophet or teacher has had in mind a privileged individual, or a privileged class, the education of a prince, of a nobleman, of a statesman, a monk, a scholar, a gentleman—always an exceptional person or class. The common people, the toilers in the fields and mines, the rank and file of soldiers and sailors, the builders of houses and ships, the craftsmen at looms and benches—for all such there were no educational theories. Such people had no education and they were supposed to need none beyond that gained in following the occupations or crafts themselves. The assumption was not only that there was no education suited to the common people, but that an interest and participation in the practical arts was degrading to the taste and deadening to the mind. To be sure, a Rabelais, or a Rousseau saw abundant reason for rebelling against the scholasticism of the grammarians, and advocated a return to a study of the external world and the methods of controlling and utilizing the forces of nature, but even they had no science of education, and they had small following.

THE RECOGNITON OF UTILITY AND SCIENCE.

Francis Bacon, more than any other man, showed the inadequacy of the classic method, fine as it was along certain lines, and the comparative worthlessness of scholasticism, and he opened the eyes of the educated people of his time to the wealth of opportunity for interesting and profitable study in the great laboratory of nature; and better than all else, he set forth the dignity and intellectual value of science

study—and he vigorously scouted the idea that the usefulness of scientific truth to any degree detracted from its educational value.

But none of the writers touching on education, with the possible exception of Froebel and Pestalozzi, not even Locke, Milton or Dr. Samuel Johnson, looked at the matter from the scientific standpoint which takes into account: first, the physiological laws which govern the growth and development of the brain; second, the exterior stimuli for promoting that growth most successfully; and thirdly, the kind and quantity of knowledge and skill one must have in order to meet most completely the demands of a carefully-selected occupation.

The history of education is full of the records of whims and fancies, of experiments real and imaginary, conducted in order to prove the worthlessness of some theories and the worthiness of others. Every parent has a dimly-defined theory of how his boy ought to be educated, and every teacher looking back over his own experience as a pupil formulates more or less clearly a 'system' for the proper education of his pupils. It goes without saying that such theories and so-called systems are generally shallow and inadequate, and I say this with no disrespect to either parent or teacher. I am both a parent and a teacher, and I know only too well how inevitably we theorize and plan, and how inevitably we go astray through lack of scientific guidance.

I do not claim to have formulated the science of education, and I know of no one living who has ventured to make such a claim; and yet I believe that a science of education is possible—and it is high time that we set about a systematic study of its essential features with a view to a formal statement of its main principles. Where can that important work be begun and carried on more appropriately and successfully than in the American Association for the Advancement of Science? Here we can bring the results of long experiences under a great variety of conditions, with unequaled opportunities for comparison and elimination.

In his 'Tractate on Education' Milton defined a complete and liberal education to be that 'which fits a man to perform justly, skilfully, and magnanimously all the offices, private and public, of both peace and war.' That is comprehensive enough, yet Milton had in mind only the offices which pertain to the five professions which were then open to liberally educated men, viz., those of the lawyer, the physician, the clergyman, the soldier and the gentleman. A 'gentleman' as defined by Milton was one 'who retires himself to the enjoyments of ease and luxury.' He had no thought then, as had not the educational writers of ancient or medieval days any thought, of the sixth estate, the great mass of the people who are coming to be the characteristic force in the civilization of to-day, viz., those actively doing the world's work, the constructive and distributive, and providing agencies of modern life. We are offering education to-day to every child, a comfortable home to every family, citizenship and self-respect to every graduate of our schools. The education we must study is the universal education of the American people. We have put science, and ever more science, into the world's work; we must now give science and culture and skill to the world's workers.

When a privileged class lived in luxury, relying upon the labor of slaves who were purposely and sometimes legally kept uneducated, and when education for culture and the accomplishments of polite society were natural and logical, it was not surprising that philosophers should hold that practical affairs were degrading. Seneca,

who lived in the first century, was indignant because Posidonius had so far forgotten himself as to credit philosophy with the invention of the arch and the introduction of the uses of metals.

Philosophy, according to Seneca,[1] "had nothing to do with teaching men how to rear arched roofs over their heads; and they were not concerned with the various uses of metals. She teaches us to be independent of all material substances, of all mechanical contrivances." The wise man, said the Roman Philosopher, lives according to nature. Instead of attempting to add to the physical comfort of his species, he regretted that his lot was not cast in that golden age when the human race had no protection against the cold but the skins of wild beasts, no screen from the sun but a cave in the earth. To impute to a philosopher any share in the invention or improvement of a plow, a ship or a mill was an insult. The invention of such things, wrote Seneca, is drudgery for the lowest slaves. Philosophy lies deeper. It is not her office to teach men how to use their hands. The object of her lessons is to form and nourish the soul.

The above wish of Seneca can be fairly paralleled by an utterance of Matthew Arnold in his famous essay on 'Sweetness and Light' (a phrase he borrowed from Swift). Arnold asks, with no evidence of doubt as to the superiority of the 'brave days of old':

> If England were swallowed up by the sea tomorrow, which of the two, a hundred years hence, would most excite the love, interest, and admiration of mankind—the England of the last twenty years, or the England of Elizabeth, a time of splendid spiritual effort, but when coal and our industrial operations depending on coal were very little developed?

That is, he would prefer an age when they had no mills, no canals, no steam engines, no railroads, no steamboats, no manhood suffrage, no common schools, few books, few newspapers and few magazines, because a great majority of the people of England could neither read nor write. *De gustibus non*—as I always say of Ruskin.

I have quoted Seneca at some length because he is a type of a class of people, ancient, medieval and modern, who, living like Seneca in great luxury upon their income, look with disfavor, if not contempt, upon all studies which have, or may have, a positive value in multiplying human comforts and in ameliorating human sufferings.

It is not many years since a president of Princeton University expressed his regret that the higher mathematics had been found useful in the study of electrical appliances, for, said he, 'as the utility of a subject increases its educational value decreases.' Such was the view of the fathers and the disciples of Greek philosophy from Socrates to Patton, but such was not the view of Lord Bacon, and Lord Macaulay, and Professor Huxley, nor is it your view, I trow; certainly it is not mine. I would as soon adopt the educational scheme of Machiavelli as that of Seneca. The former in all frankness and candor pictured the intellectual and moral dishonesty and hypocrisy of his time; but his life was relatively clean. As for Seneca, he sang the praises of virtue and literary culture, and then closed his career by an exhibition of meanness, ingratitude and corruption which threw a blanket of infamy over his fine advocacy of a philosophy which was to form and nourish the soul.

Is it not evident from the standpoint of the subjects to be studied that we need a science of modern education? Educational values are to be determined, taking into consideration age, sex, environment, taste, brain development and probable sphere of usefulness.

[1] Episto, 90.

THE DOCTRINE OF INTEREST.

Here two important subjects crowd upon me for consideration, and they are just the subjects which I wish to lay before a section devoted to the science of education. They are closely related, and I suspect they are strictly modern. I refer to the doctrine of interest, as a valuable or as a harmful characteristic of study; and to the wisdom or the folly of a free election of studies in our secondary schools and colleges. Consider for a moment how much we are at sea and how far we have drifted apart on these two matters—and then you will agree with me as to the need of systematic study and observation that we may find our bearings and lay our courses correctly.

The question of taste and interest is a very perplexing one. Antecedent interest is, we all know, quite accidental and a very unsafe guide. The whims of boys and girls are generally due to the suggestions of companions and of external opportunity. It has been my fortune, as well as my duty, to warn hundreds of parents of boys from fourteen to eighteen years of age not to take seriously their early interest in particular studies or their haphazard plans for future occupation.

Some choice is inevitable, and plans for the distant future are as plenty as castles in Spain, but nothing can be more evident than the unfitness of a boy in his teens to select definitely the course of study best suited to his inherited and acquired capacity; and nothing can be more certain than his practical ignorance of the conditions of a successful career. Hence his declared preferences and elections are to be treated with a loving sympathy, as are a hundred other youthful fancies, but the wise parent and the wise teacher decide to leave open all the avenues of culture and skill, and to hold off the great final choice till the boy has had time and opportunity to make two important discoveries, viz., the intellectual world within him, and the material and spiritual world without. Here we need the pronunciamento of science, telling us how much weight we shall attach to the preferences of a boy of twelve, of fifteen, of eighteen, in regard to the scheme of education and training which shall enable him to make the most of himself and be of the most use to his time and generation.

Every good teacher aims to make his subject as interesting as possible to his pupils. If they fail to take a lively interest in it, something is wrong; either it is not properly presented, or it is over their heads; or it is clearly of no earthly use. Natural lack of capacity on the part of the child is rarely a valid reason for failure, if the child be healthy and normal. I have learned to discredit the truth of the oft-told tale that 'John has no capacity for' such a subject—mathematics, for example. "He never could learn mathematics—he takes no interest in algebra and he hates geometry," etc. Our higher schools and colleges are full of young people who protest vigorously that they never could and never can understand, or take any pleasure in, or gain any profit from, certain studies. On the other hand, I firmly believe that every normal person, at least nine out of ten of the children and youth at school and college, can fairly master and actually enjoy and profit by not only mathematics, but by every subject in the curriculum, if it be properly taught, and under proper conditions as to age and preparation.

I know a man who when a boy was put too early and too rapidly to arithmetic, algebra, geometry, trigonometry and analytics. He must have had the worst possible teachers, for he comprehended nothing of what he glibly recited from memory. So they called him a dunce, reported him home as a dunce, and the boy accepted the

oft-repeated verdict and believed himself a dunce in mathematics. He would have gone through life with that conviction stamped into his brain had not chance thrown a West Point appointment in his way. Spurred by pride and ambition, he resolved to review arithmetic by himself and at least pass the entrance examination to the military academy. To his great surprise he found arithmetic easy to his maturer powers and very interesting, and he entered the military academy with flying colors. Then he took all of the mathematics which he had hated over again. They were a delightful revelation to him. He graduated among the engineers, a fine mathematician, and he is to-day at the head of an engineering school of high grade. I have the story from his lips.

I have had unusual opportunity to observe similar cases, and in a measure to help students who have been the victims of bad judgment on the part of teachers or parents, and so have been led or allowed to dislike subjects which they should have enjoyed, and to underrate their mental faculties because they had attempted to exercise brain cells which were not yet properly developed.

The importance of this subject can not be overestimated. How many lives have been shortened; how many intellects have been dwarfed and stunted; how many careers have been partial failures—all due to early and inconsiderate teaching. Opportunities to redeem and save those of great possibilities, like the one I have mentioned, are rare—and the vast majority of victims never fully recover. In our zeal we have often overshot the mark. The proverbial intellectual strength and vigor of country boys coming up to the university is due not wholly to outdoor life, physical exercise and plain food. I am inclined to believe it is due in part, and perhaps a great part, to their escape from too much schooling and too much crowding. What the country boy needs (and what he often lacks) is not so much longer sessions and rapid promotions as more accomplished teachers.

A word more about the importance of interest as a condition of healthy mental growth. I maintain that attention is as necessary to the growth and development of the brain as exercise is to the development of a muscle; and that interest is the condition of a lively attention. When in a school or lecture room the limit of close attention is reached, the lesson or lecture should close, for the educational process has already stopped. It is not only useless, but it is worse than useless, to go on when the class or audience refuses for any reason to attend. I, therefore, doubt the educational value of subjects which are not, and perhaps can not be, made interesting.

Of course I do not claim that all selected studies can be made equally interesting, or that any one study can be made equally interesting to all pupils, even when the pupils are properly graded; but I do claim that a lively interest is necessary, and that educational progress is very nearly proportional to the strength of that interest.

But all educators do not agree with me here. A Harvard professor recently wrote as follows: "The practical aim of a general education is such training as shall enable a man to devote his faculties intently to matters which of themselves do not interest him. The very fact that the abstractions of mathematics must generally seem repellently lifeless, is part of the secret of their educational value." He praises the 'elder education' which "through daily hours, throughout all their youthful years, compelled boys, in spite of every human reluctance, to fix their attention on matters which, of themselves, could never have held attention for five minutes together."[2]

[2] Professor Wendell, *North American Review*, September, 1904.

This advocacy of ten or twelve years of uninteresting studies, none of which could hold the attention for five minutes unless they were forced upon the student—as the best preparation for dealing with the interesting matters of real life, such as earning one's bread, building a home, rearing a family, contributing to the common weal, and achieving the highest success—this remarkable doctrine is the product of our own age. No ancient or medieval teacher, so far as I am informed, ever promulgated or defended it. The credit or discredit of its authorship belongs to our own day and generation. On the other hand, that veteran and very sensible writer, John Locke, two hundred and fifty years ago, said: "The great skill of a teacher is to get and keep the attention of his scholar. To attain this, he should make the child comprehend the usefulness of what he teaches him, and let him see, by what he has learned, that he can do something which he could not do before; something which gives him some power and real advantage."

I join Professor Wendell in discounting the whims and fancies of children, and in his estimate of the value of an unintelligent choice of studies; but we must part company when he would force me to accept the doctrine that I must be careful not to make my mathematics and mechanics very interesting, lest their educational value be impaired. May I not refer this matter also to a section on education?

FREE ELECTION OF STUDIES.

Closely related to the above is the great question of elective courses of study in our colleges. Personally, I am less concerned with this, since in the school or college of engineering with which I am connected, the curriculum is carefully laid down, and there is no election till the end of the freshman, and generally not till the end of the sophomore, year—and even then only a single election of a carefully prepared line of study is allowed. But I have been a more or less interested observer of the working of a free elective system elsewhere. I am not now going to discuss it, or to weigh it in the balance of experience. Such a discussion of its theory and practise would occupy a full paper before an educational section. Science teachers and scientific men are, or should be, deeply interested in this matter, for, if I mistake not, the rush for certain branches of science, and away from the traditional studies, has led in many cases to the calling of a halt in the freedom of election. My own conviction is that the pendulum has swung too far. The number of required studies should be increased and the later years should be given to a group of subjects selected from a list of groups prearranged by the faculty. It is perhaps not quite safe to condemn a system which permits a student, having entered college on substantially the old requirements, to go through and graduate with honor, without giving during his entire college course a single hour to any one of the three corner-stones of the old curriculum of my college days: Latin, Greek and mathematics—but it certainly raises a question in the mind of every reader of educational history. Is there not a golden mean between predestination and free-will in the matter of studies and educational values?

OTHER EDUCATIONAL QUESTIONS—ATHLETICS.

Never, since the days of Grecian games at Olympia, has physical culture, including field athletics, been so prominent a feature of student life as now. We can truthfully say that to-day athletics is the most conspicuous part of an academic education. Unquestionably the curriculum is out of balance, and a readjustment is necessary. The healthy, normal boy (and I may add, the healthy normal girl) requires and enjoys vigorous exercise in the shape of

games. While I advocate rational athletics, I deeply deplore semi-gladiatorial exhibitions which put the emphasis in the wrong places, and which mislead and demoralize the entire student-body. There has been a drift backward of late years towards a species of barbarism, which we had fancied we had outgrown. It becomes scientific men to restore, or better, to establish, a condition of educational equilibrium.

I can not even mention all the matters of prime importance which would speedily come before an educational section. The organization and functions of boards of education are matters of the greatest moment at the present time, and I suspect they have a perennial interest. It is already on the program of one of your sections.

Some thirty years ago kindergartens were incorporated into the course of instruction of the public schools of St. Louis, and later into the schools of many other cities. The constitution of the state of Missouri—very unwisely, I think—does not allow children under six years of age to attend any form of a public school; yet we shall all agree that the best kindergarten ages are the fifth and sixth years. Nevertheless, nearly every child in St. Louis for the last thirty years has attended kindergarten during his entire seventh year, taking up the primer for the first time upon entering the 'first grade' when seven years old.

In spite of occasional protests and claims that valuable time is thereby wasted, the plan is fairly popular and there is no near prospect of change. The later progress of the relatively mature children in the first grade is remarkable, and many observant principals think that ultimately no time is lost. As for myself, my judgment is in suspense, and yet I have sent five children to the kindergarten. It is always difficult to compare what has been with what might have been, and with what would have been, had things been different. Suppose I refer this all-important matter to scientific educators.

PHYSIOLOGICAL PSYCHOLOGY.

Perhaps the most valuable contribution to the science of education has come through a study of the laws which obtain in the growth and development of the brain, and the conditions under which that growth and development is most healthy and complete. There are times and seasons for the development of the mental and moral faculties as there are of the physical faculties. While such times and seasons are not precisely the same for all children, we find that all attempts at premature development are not only worthless, but are permanently injurious. Precocity is now regarded as a species of brain deformity. Plants and animals may be forced, and unusual and interesting results may be produced by forcing, but no one of us wishes a son or a daughter to be a prodigy in one direction at the cost of normal development in other directions.

The psychologists tell us that the brain cells develop as do other physical organs, not only through thought, but through muscular activity and the exercise of our senses. Accordingly, a healthy and timely growth and development of the brain is to be promoted by an education involving a great variety of activities, skilfully adjusted as to quality and quantity to the mental and physical status of the child. I have often thought, when candidates for admission to Washington University present themselves, that, instead of asking them several sets of questions on a variety of somewhat conventional subjects, I would like to take off their skulls and brain coverings, and see how fully their primal brain cells were developed, and the extent to which the network of intercommunication between cells had been established and was

in good working order. Such an examination would tell far more than any mere written examination. To be sure, I might find it difficult to read and interpret what would be written there, but the record would be there to the minutest particulars.

This branch of my subject outruns both my time and my ability. But there are experts, and they are veritable men of science, and they are most welcome to the companionship and fellowship of this association.

MANUAL TRAINING.

Closely related with this of brain culture is the subject of manual training, which has recently gained a foothold in our scheme of rational education. Its nature and educational value are still under discussion. This relationship is well shown in a paragraph which I take from one whom I am always glad to quote.[3] Said he:

> In man, the size of the motor area in the brain depends far more on the complexity of the movements affected by a group of muscles, and on the fine coordination of these movements, than on the mere mass of the muscles involved. Physical energy implies a good motor brain area. The man of energy is a man of brains, no less really than the man of thought.
>
> Physiologists distinguish muscles as 'fundamental' and 'accessory.' The fundamental muscles are the large masses of muscles used in locomotion and in performing movements requiring strength rather than fine adjustments and delicate coordinations. They are, for the most part, the muscles which we have in common with the lower animals and which we have probably inherited from our forefathers who dwelt in trees. The accessory muscles are those which involve fine coordinations. They are principally the muscles of the forearm and hand, and those of the vocal organs. Now it might be argued that manual training is not necessary for the development of the motor centers in the brain, on the ground that gymnastics and outdoor physical exercise are quite adequate to accomplish it. The answer to this objection is the fact that gymnastics and physical exercise in general, appeal almost exclusively to the fundamental muscles and their brain centers, and rarely to the accessories. Nothing short of manual training will reach effectively the important brain cells governing the fine motor adjustments of the muscles of the hand, as nothing short of actual speaking and actual singing can ever effectively develop the equally important brain cells governing the muscles of the vocal organs. The motor cells of the brain controlling the muscles of the joints nearest the trunk develop first, and later, in regular order, those which control the muscles of the more distant joints. Education ought to follow this order of growth; it should avoid training the fingers to make finely coordinated movements at a period when nature has not yet got beyond developing brain cells to make the coarser adjustments of the shoulder and elbow joints. Physical training, which appeals to these more fundamental muscles of the proximal joints, should at first precede manual training, which appeals especially to the muscles of the forearm, hand and fingers.

[3] Professor Thomas M. Balliet, of the University of New York.

We have in the above statement a scientific explanation of the educational value of manual training, so far as it relates to the growth and development of the brain.

As some of you know, I have had something to do with the introduction and defense of manual training as an educational feature. There was from the first no question of its economic value to the great mass of American boys, and largely for that reason it met with favor among people who were more concerned with the work the boy would be given to do after his brain and hands had been developed, than with the means and activities by which the finest and most useful development of the whole boy could be secured.

A study of the whole field of education, classical and technical, led me, in 1879, to organize a school for boys of high-school age in which manual training should be combined with intellectual training; to put the liberal arts and the mechanic arts side by side in the same curriculum; to deal simultaneously with material forces and appliances and with spiritual forces and appliances; to cultivate not alone or chiefly

the memory and the understanding, the eye to read and the mouth to speak, but the judgment and the executive faculties as well; to extend the humanities so as to include human interests and human activities as they exist now and here. Many wise and excellent educators had grave fears as to the result of the experiment. It was thought that the introduction of tools, machinery, materials, the theories of construction, and draughting, might not only break up the orderly program of the school, but they would lower its intellectual and moral tone. It is now known that all such fears were groundless. Manual training, when properly adapted to the boy's status of brain development, and when incorporated into the daily and weekly program with due regard to the other essential features, has proved to be a more valuable element in education than even the most sanguine advocate dared to expect. The moral, intellectual and economic fruit of this combination, as shown in the characters and careers of the boys who formed the first classes in the pioneer schools, is the best possible evidence of its value. The gloomy predictions made of its effect upon the pupils, and upon our American system of schools, have been forgotten, and early opponents are fast friends and enthusiastic advocates.

This is no place nor time for me to give an exposition of manual training; I have preached its gospel elsewhere and often. But I mention it as one of the important matters which must be carefully weighed and adjusted. We must defend it from frivolity on the one hand, and from misdirection and undue emphasis on the other. At first it was suspected that our motives were sordid; that we were likely to degrade our schools, to teach narrow trades, and to turn out 'mere mechanics' instead of educated men. On the other hand, a recent report of a Massachusetts commission (for whose membership I cherish high respect) regards the manual training movement as almost exclusively educational and not sufficiently industrial. I suppose the earlier and the later estimates are still held by many sincere and able teachers. One does not easily lay aside the convictions of a lifetime. The manual training movement stands inevitably as a criticism upon the system of education which came down the ages through the fathers to us, and naturally the latter stands on the defensive. It is also a standing reproof to the old wasteful, unscientific method of teaching to apprentices the theory and uses of tools. It is for educational science to justify the ways of progress which lays aside the idols of the past and erects new temples and opens new kingdoms. Of all the temples, none is finer, none is more glorious and none should be more scientifically planned and reared than that of education. While no section of this association can enforce the dictates of science, it would be helpful if we were able to establish these two things as true, viz:

1. That usefulness does not impair educational values.

2. That a so-called culture-study like Latin may properly stand side by side with manual training in the curriculum.

We are all pleased (though perhaps surprised) when we learn that a man who reads blue-prints, and can make and use a diamond-point machine-tool, is also a linguist and at home in the calculus; and yet we are more than likely to assume that the boys who are studying the theory and use of tools have little need of literature; and that the student of the classics is wasting his time in a laboratory of the mechanic arts.

"What are these boys studying Latin for?" said an English visitor at the manual training school as he looked in upon a class reading Cæsar.

"What did you study Latin for?" was my illogical but American response.

"Why, I am a bachelor of arts!" was his prompt reply, with the air of one who had given a conclusive answer.

"Perhaps these boys will be bachelors of arts by and by," I added cheerfully.

"Then, what in the world are they in a manual training school for?" he exclaimed, with almost a sneer at my evident lack of acquaintance with the etiquette of educational values.

I tried to explain my theory of an all-round education—and my practise of 'putting the whole boy to school'—but he would not be convinced. He could not see the propriety of mixing utility and tool dexterity with culture. Our visitors are not all Englishmen; yet I venture the estimate that fully one half of the bachelors of arts who look through our study rooms and our work rooms have about the same prejudice as the Englishman had, though they do not so openly express it.

THE NEW EDUCATION.

The evolution of the fully fledged technical school, or the technical department of the university, has taken place during the last half century, and yet its broad stimulating, attractive features have a following which bids fair to double the attendance of college and university students. This does not mean that letters and polite learning are being neglected, but that a new constituency is eager for the new education. This new education, though it recognizes at all points a high order of usefulness, and contains little that is conventional, is only remotely professional. If ever its curriculum becomes narrow, it is quickly condemned by the best representatives of an education which combines utility with culture. No longer can the 'Levites of culture,' as Huxley calls them, claim to monopolize liberal education. The new education can be as liberal as the old, and both can be narrow. Fortunately, they flourish side by side and the future shall choose the excellencies of each. An adequate science of twentieth-century education will evaluate the characteristics of each, and bring the wisdom of the past, not its foolishness, to nourish the wisdom of the future.

In conclusion, let us not fear to lay the foundations of the science of education broad enough to carry and to advance our twentieth-century civilization. Let us not fear to strike out for ourselves when the age presents new demands. Progress is essential to life, as Browning says:

> What comes to perfection perishes.

I see nowhere, in either ancient or modern times a people whose youth have been trained as our Americans should be trained. Neither Greece nor Rome with their pinnacles of culture resting on the barbarous foundation of human slavery, nor the blooded aristocracies of modern times, can teach us how to educate, train and adorn an American citizen. We must not expect all our students to rule, nor yet all to be ruled; to direct, nor yet to be directed; to employ, nor to be employed. They must be capable of all these things. No narrow, selfish aim, no prejudice of caste, no false claim of high culture which scorns service, must mislead the growing, expanding minds. Give them a generous, symmetrical training; open wide the avenues to usefulness, to happiness, to power; and this age of scientific progress and material wealth shall be also an age of high intellectual and social achievement.

CALVIN M. WOODWARD.
WASHINGTON UNIVERSITY.

SCIENTIFIC BOOKS.

The Nervous System of Vertebrates. By J. B. JOHNSTON, Professor of Zoology in West Virginia University. Pp. xx + 870; 180 figures. Philadelphia, P. Blakiston's Son and Company. 1906.

The study of comparative neurology has always been regarded as difficult, often as uninteresting and sometimes as unprofitable. However much we may ameliorate the first of these difficulties by improved pedagogic devices, we can not hope to make much progress in this direction until the stigma implied in the second and third is eliminated. The mere descriptive anatomy of the nervous system is truly uninteresting and, like any other uncoordinated mass of intricate detail, relatively unprofitable. Only in so far as the nervous system can be described in terms of its functions has its study any value from any point of view; and it is in respect to just this correlation that the past literature of neurology (both text-books and monographs) has been notably weak.

The technique of modern neurological research is so very difficult and diversified and the mass of intricate anatomical detail which must be carried in mind during the progress of investigation so vast, that the neurologists have not, as a rule, been able to control their anatomical findings physiologically as the work progressed. Though anatomical research normally precedes physiological, yet the gap between them can not properly be left so wide as neurologists have been inclined to leave it. Even in pathology, though a few years ago there was a vigorous movement toward a correlation of anatomical and clinical observation, yet the results were disappointingly sterile, and now the tendency is to lay more emphasis on clinical work alone, leaving anatomical research to be cultivated apart by specialists in that field. This surely is not a creditable situation. And though it would doubtless be unjust to place the responsibility on any one specialty alone, yet clearly the anatomists must carry their full measure. For it should frankly be recognized that, though neurology has contributed much to physiology, psychology and psychiatry, yet the direct positive help given to these sciences is not at the present time commensurate with the vast accumulation of laborious research represented in our literature of neurology. And this is particularly true of comparative neurology, which should logically lead in practical fruitfulness.

Professor Johnston's manual strikes at the root of this evil. It is a text-book of functional neurology. The unit of his descriptions is the functional system of neurones, that is, the aggregate of related neurones which cooperate in the performance of any given type of reflex movement. The analysis of these functional systems is a matter of extreme difficulty, involving the collective use of various refined anatomical and physiological methods, but it is obviously so much easier in the brains of lower vertebrates than in the human brain that the comparative method has been here most fruitful. After four introductory chapters, Johnston devotes himself in the remainder of the book to an exposition of the functional divisions of the vertebrate nervous system and their phylogenetic history. The style is direct and clear and the illustrations numerous, so that the student who is equipped with an elementary knowledge of vertebrate anatomy and embryology should be able to follow the author, even though his method and subject matter are for the most part distinctly different from those of the other text-books in general use.

Chapters five to thirteen include the definitions and tabulation of the functional systems, followed by a detailed description of each and its phylogeny. Chapters fourteen to nineteen follow with a similar exposition of the structure and evolutionary history of the centers of correlation, including the cerebellum, mid-brain, thalamus, fore-brain and neo-pallium. These fifteen chapters taken as a whole constitute the most ambitious attempt which has yet been made to elaborate a phylogeny of the vertebrate nervous system. At no time previous to this could such an endeavor be expected to yield more than a limited measure of success; but by basing his phylogenies upon functional units of internal structure instead of superficial external features the author has succeeded in demonstrating the unity of plan of the vertebrate nervous system with gratifying completeness and in showing that this plan is unexpectedly simple. All of the important known stages in the evolutionary his-

tory of these functional systems are illustrated by clear diagrams. The mastery of these simple diagrams will give the student the principal landmarks for all of his subsequent study of cerebral morphology.

While this work is primarily a text-book of the morphology of the nervous system, its great merit lies in the fact that its facts so far as they go also express the functions of the parts, so that comparative physiology and comparative psychology will both find in it an immediate point of departure for their special researches. It will form the natural preparation for such courses and also for courses in human neurology, for it is not designed to take the place of any of the manuals on the human nervous system. Very little space is devoted to the human brain alone except in the chapter on the neo-pallium, yet every chapter is essential to the comprehension of the corresponding human structures, a claim which can hardly be made for any previous work on comparative neurology.

This book is an outgrowth of the work on nerve components inaugurated by the American school of comparative neurologists and no estimate of the validity of the conclusions arrived at is possible without a study of the series of memoirs on nerve components and functional divisions of the brain upon which it is based. This work is still so incomplete that any attempt to summarize its results is necessarily fraught with the dangers of too hasty generalization. And it would be rash to claim that all of Johnston's suggested homologies will stand the test of time. This much may be said, that they are not out of harmony with the facts as at present known, and where his conclusions can not be regarded as definitely proved they are sure to be stimulating and helpful in pointing the way toward the truth; for the basis of the work is sound and the leading conclusions abundantly supported by the singularly concordant results of the studies of the new school of comparative neurologists.

C. JUDSON HERRICK.
DENISON UNIVERSITY.

The Loose Leaf System of Laboratory Notes. By THEO. H. SCHEFFER, A.M., Kansas State Agricultural College. P. Blakiston's Son and Company.

The laboratory note-book is a subject of more or less interest and importance to every laboratory teacher. In some cases its value may be underestimated, and as a consequence the note-book, as an index of the laboratory work of the student, is an almost negligible quantity. On the other hand, there is the tendency to exaggerate its value and overestimate its importance, with the result that it may become the inflated repository of elaborate compilations from every available source, including elaborately detailed drawings, artistically executed, and involving an immense outlay of time and energy, and finally bound up in morocco covers.

Between these extremes are to be found all sorts of intermediate ideals and practises, somewhere among which the 'Loose Leaf System' under review may be listed. Briefly distinguished, it consists of a series of printed laboratory directions for the study of some twenty-one types of animals, from protozoa to birds, the whole loosely tied up in binders' boards, and so arranged as to allow the inclusion of the students' notes in connection with directions given for each type.

So far as the directions themselves are concerned they furnish about what every laboratory teacher provides, namely, a manual of directions, either printed or typewritten, to facilitate and systematize the students' work. The directions here provided furnish a fairly adequate outline for an elementary course in zoology of perhaps a single semester. The chief criticism, from the writer's point of view, is that the directions follow too closely the *verification* method of the older manuals, rather than the *interrogatory* method; that is, the student is too fully advised as to *what* is to be seen and *how*, instead of suggestively presenting him with a series of problems for solution, or opening before him avenues of discovery.

In general, the subjects are well presented, and with comparatively few errors of statement. One such may be pointed out in connection with the study of the medusa, *Gonionemus*, where it is said that 'like all hydroid

medusæ it buds off from plant-like masses of fixed hydroid polyps.' As a matter of fact, this medusa forms a conspicuous exception to the general rule and does not arise by budding, as in *Obelia* or *Pennaria*. The typography and press work are excellent. The mode of binding is, however, far from ideal. Much better covers for such notes are now provided, which are far simpler and more effective than the rather crude 'shoe-string' method used in this book.

C. W. H.

The Subconscious. Joseph Jastrow. Boston and New York, Houghton, Mifflin and Co. Pp. ix + 549.

This book is not so much a theory of the subconscious or an analysis of the concept of subconsciousness, as an attempt to schematize certain portions of normal and abnormal psychology, on the basis of a definite assumption of a subconscious, the conception of which, however, is very indefinitely outlined. The course of the whole exposition is directed toward a specific development of a familiar theory of the self. The treatise throughout is furnished with a wealth of illustration which may be of use to the instructing psychologist, but it is embellished with a profusion of metaphor, simile and analogy, which, under the author's mastery of polysyllabic verbiage, gives rise to a florid fluency apt to cause the newly introduced reader to lose the path of the argument amidst the rhetorical gardens which surround it.

In the ten chapters of Part I., which deals with the normal consciousness, the author takes us through an elaborate exposition of the doctrines of habit, attention, automatic action, will and self-consciousness, with which we have been made familiar by James. This part seems apt to be found of much use for students covering intensively these topics of psychology.

It is in this part, however, that the concept of the subconscious (or perhaps we should say the term subconscious) is made a useful basket for the reception of the odds and ends left loose by more timid authors. First is shown how processes go on without consciousness. Then in Chapter VI. (The Mechanism of Consciousness) is assumed a subconscious control without definite definition of the same, and the 'apportionment of mental life to the subconscious and conscious participants' is discussed, the topic being continued through the succeeding chapters.

In the course of this discussion, not only are various types of automatic and habitual action handed over to the responsibility of the subconscious, but active recall, and spontaneous trains of association in sleep or waking, are construed as the 'bringing of the subconscious activity to bear for the service of the conscious.' The associative mechanism in general is said to 'find its sphere of activity largely in the subconscious realm.' Self feeling is said to be strongly tinged with subconscious elements; subconscious feelings of our own importance, of the attitude of others, etc. By way of strengthening the useful concept, the experimentally ascertained effects of imperceptible stimuli on consciousness are cited.

So far, the term subconscious covers the general field of (1) unconscious control of activity, (2) production of conscious effects by factors not themselves in consciousness, and (3) vague consciousness.

In Part II., which deals with abnormal phenomena, dreams, hypnagogic hallucinations, deliria, drug intoxications, somnambulisms, hypnotic states, hysterias, and alterations of personality, or the psychological side of these, are considered and described on the basis of the same concept (or term) of the subconscious. The principal factor in these abnormalities is almost stated to be the dominance of the subconscious as over against the dominance of the conscious in normal experience.

In general the rôle this subconscious plays is shown as identical with that in the actions, perceptions and associations of normal consciousness. The important new phases which are reduced to a basis of subconscious activity are: (1) anesthesias, which are shown to be not physical losses of sensibility, and to be even psychically contradictory, (2) confusion of hallucination with reality, and (3) the loss of conscious control over actions which yet go

on with physical perfection and certain teleologicality, and are somehow registered. The standard cases of alteration of personality are cited in some detail, but their bearing on the general problem, aside from their nature as extreme cases of dissociation, is not made clear.

This part of the book is rather a miscellany of illustration and comment which might be interesting to the lay reader, than a systematic treatise available for the student.

In the third or theoretical part the author goes again over the whole field, discussing the participation of the subconscious, and raising the question of its status, but evading any answer more definite than that it 'though not in consciousness may be said to be of it.' In the second part he expressed his belief that dissociation involves a 'central dominating agency from which the dissociation takes place,' that an experience is made ours only by a synthetic 'act of incorporation,' and that the nebulously conceived subconscious is the 'non-personal, non-synthetized' experience. To this factor of selfhood he now adds two others, leading finally to the statement that it is the privilege of the psychic experience to arouse a realization of its place in the series (*incorporation*), and of the background that is passing (*orientation*), and of the fact that it is moving (*initiative*). Such realization involves the conception of a conscious self. Anesthesias of abstraction, somnambulism, hypnosis and hysteria are 'practical symbols' of impairments of incorporation, 'a state of mind in which the psychic movement persists, but without obtaining normal acknowledgment.' Loss of orientation manifests itself characteristically as confusion of subjective and objective: the crediting of hallucination as in hypnosis, delirium and hysteria, being consequent on anesthesia, which cuts off the normal corrective judgment on which orientation is based. Light forms may be mere bewilderment or doubt. Impaired initiative is 'impulsion' or loss of control over motor activities, as in automatism. The typical form is 'substitution for spontaneous action of an impulse imposed from another source than the directive will.'

These three realizations are the characteristics of self, and therefore, when they are impaired, the self is impaired. The various abnormalities previously treated lend themselves very nicely to generalization under these heads, which, however, to the reviewer seem to add very little to the explanation or better understanding of the phenomena.

The general course of the schematization in terms of the three components of selfhood would lead us to expect a vital impairment of all three in decided alteration of personality. 'With the conjoint impairment of all, an altered state (of the self) is induced,' the author says, but comes no nearer to an analytical application to the cases of alteration cited in Part II., leaving us, therefore, to be content with the inference that although 'conjoint impairment' *would* produce decided alteration of personality, the typical and accepted cases depend entirely or largely on 'loss of incorporation.'

In spite of the few criticisms above incorporated the book is a strong and interesting one, displaying the extent and intent of Dr. Jastrow's grasp on the field which it covers. It is to be hoped that the volume is what it appears to be, namely, an expression of intention or preliminary filing on the said field, and that it will be followed shortly by a more exact and basic work from his pen, a contribution which would be highly appreciated by all students of this obscure portion of the psychological domain.

KNIGHT DUNLAP.

SCIENTIFIC JOURNALS AND ARTICLES.

Bird-Lore for November-December opens with an account, by Edgar F. Stead, of 'The Wry-bill Plover of New Zealand,' the only bird in which the bill is noticeably bent sidewise. It is stated that this bird is dying out without apparent cause. Other articles are 'Our Garden Mockingbird,' by Mrs. F. W. Roe; 'Tame Wild Geese' (visitors to Golden Gate Park), by W. K. Fisher and 'Italian Bird Life as it impresses an American Today,' by F. H. Herrick. This might better be called, the *absence* of bird life, small birds being scarce in Italy, their place as insect

destroyers being taken by lizards. W. W. Cooke gives the seventeenth, and last, paper on the 'Migration of Warblers.' It is noted that the colored plates of warblers will be followed by those of the thrushes, and these in turn by the flycatchers, it being the laudable ambition of the editor to figure in time (a slip in the types makes it in the next volume) every species of North American bird. The number contains the Annual Report of the Audubon Societies, which shows a gratifying increase in bird protection throughout the country, though much yet remains to be done in arousing public sentiment in favor of protection, and the enactment and—what is more important—the enforcement of laws.

The Museums Journal of Great Britain for November contains articles on 'The Significance and Scope of a Museum in Lienz,' by A. B. Meyer, being advice as to the objects and administration of a local museum; 'The Equipment of a School Museum,' by Oswald H. Latter, showing the museum from the teacher's point of view; and, under the head of 'International Bureau of Ethnography,' a free translation of the memorial adopted by the congress at Mons, Belgium, in 1905. The object of the bureau, which is to be established in Brussels, is the organization at common expense, of services pertaining to the scientific documentation relative to the social state, the manners and customs of different peoples, especially peoples of inferior civilization.

The Geological Survey of Canada has recently issued a 'Catalogue of Publications' that forms a most acceptable addition to the literature of geology. It is divided into various parts, the first containing 'Reports of Progress, Annual Reports and Summary Reports in Order of Publication.' Part II. contains 'Publications arranged according to Locality'; Part III. contains 'Authors' Reports,' arranged alphabetically; Part IV. is a list of reports according to their principal topics, economics, paleontology, etc.; Part V. comprises the 'Principal Reports in the Director's Summary Reports since 1894'; Part VI. is devoted to 'Reports on Economic Subjects included in the Reports of the Mines Section' and Part VII. is a list of maps.

SOCIETIES AND ACADEMIES.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

The 418th meeting was held on October 20, 1906, President Knowlton in the chair and about fifty persons present.

Dr. Evermann called attention to the capture last August (28) of a Pacific Chinook salmon, weighing 5¾ pounds, in Sunapee Lake, N. H., the second example of this species known to have been taken in Atlantic waters. This is the result of the introduction by the State Fish Commission in the spring of 1904 of fry hatched from eggs furnished by the U. S. Bureau of Fisheries. The bureau has made numerous plants of Chinook salmon in eastern waters, but, though a 14-pound specimen was caught in Lake Ontario several years ago, had despaired of establishing the species, and had begun to introduce the silver and humpback salmon with which it feels more confident of success. The Sunapee specimen was not over two and a half years old, and it seems probable that the conditions in that lake are favorable and will result in the permanence of the species on the Atlantic side.

Dr. Rose exhibited a photograph and specimen of a very curious compact desert plant[1] which resembled a giant puff ball, but with corky bark and grass-like leaves. The plant was introduced into England sixty years ago, but female flowers and fruit had never been collected until found by Dr. Rose in Mexico in 1905. These show that the plant is near Nolina and Dasylirion, but of very different habit and fruit.

Mr. Piper showed a specimen of the Japanese 'hagi,' a plant, *Lespedeza bicolor*, from the Arlington farm, and called attention to the peculiar form of fasciation which consisted in the flattening of the branches.

Mr. W. J. Spillman presented a paper on the 'Mechanism of Heredity.' It was pointed out that our present knowledge of cytology apparently enables us to form a satisfactory theory of heredity. The fundamental assumptions necessary to the theory are as follows:

1. The chromatin is the material in which hereditary qualities inhere. This assumption

[1] '*Calibanus*, a New Genus of Liliaceous Plants,' Contr. Nat. Herb., 10: 90, 1906.

accords with the views of practically all biologists.

2. The chromosomes retain their identity. This assumption has been arrived at independently of any theory of heredity, and represents the opinion of many investigators. It has not, however, been fully established. In case it is shown that the chromosomes do not retain their identity, the reasoning by which the present theory of heredity is developed may be applied to the subdivisions of chromosomes which are the ultimate biological units, so that the theory, in its essential outlines, is independent of the theory of chromosome individuality.

3. Synapsis in organisms exhibiting alternate inheritance consists of the union of homologous chromosomes received from different parents. This is the view arrived at independently of theories of heredity by the majority of investigators.

4. If the chromosomes themselves are the ultimate biological units, in the first postsynaptic division the position of bivalent chromosomes is so far governed by chance that any given segment of the bivalent is as liable to go to one pole as the other. This conclusion was arrived at by Sutton independent of theories of heredity, and its possibilities have been pointed out by Cannon, Boveri, Wilson and others, who have also called the attention of the relation of this phenomenon to the laws of alternate inheritance.

If independent unit characters reside in the same chromosome, alternate inheritance shows that two homologous chromosomes must exchange character determinants. There is no cytological evidence of such exchange. It is admitted as a possibility. If it does occur, the theory here developed will apply to character determinants consisting of subordinate constituents of the chromosomes as it is here developed for the chromosome itself. Since there is evidence of the chromosome distribution called for by alternate inheritance and no evidence of such distribution of parts of chromosomes, we accept tentatively the simpler assumption that chromosomes retain their identity and are the bearers of hereditary characters. The following facts follow as necessary consequences of the above assumptions:

Two characters inhering the same chromosome are transmitted together. Cases of such gametic coupling of characters were cited. The facts of alternate inheritance and of evolutionary changes are made clear without resort to ids, pangens or other elements subordinate to the chromosomes themselves. Illustrations were given of the mechanism by which Mendelian characters, both simple and compound, are distributed to progeny.

Many mutations may be accounted for as the sudden appearance of characters which have developed through an indefinite period unsuspected until a chance cross revealed their identity. Examples of such characters were given.

Mendelian unit characters are, for the most part, non-essential characters. When vital characters attempt to become Mendelian, which they continually do, they lead to elimination by natural selection.

The chromosomes of a given nucleus are not essentially differentiated with regard to vital characters. That is, vital characters are functions common to all chromosomes, and hence do not obey Mendel's law, but a different law, which was stated.

Mendelian unit characters (simple characters) are functions of single chromosomes or a single pair of homologous chromosomes. (Homologous chromosomes are those that unite in synapsis to form a bivalent and are supposed to relate to the same characters.) Homologous chromosomes are of common recent descent.

Non-homologous chromosomes are not of common recent descent, but are of common descent in the distant past.

Synapsis and reduction require the finest adjustment of function of any office performed by the chromosome, as shown by the sterility of hybrids. Hence, organisms that interbreed freely must vary together if they vary at all. Isolation (cessation to interbreed) is, therefore, the prime condition in the differentiation of species.

Natural selection affects evolutionary changes in the following ways:

1. Homologous chromosomes must retain sufficient similarity of function to function together in synapsis and reduction. They may vary in function, but must vary together.

2. Non-homologous chromosomes must function together in mitosis and in synapsis and reduction. Hence, if they vary in a given interbreeding group, they must vary together within narrow limits.

3. Chromosomes must not disagree in the expression of vital characters to such a degree as to interfere with the development of a perfect organism.

4. In non-essential characters that do not interfere with proper functioning in mitosis, synapsis, and reduction and in the development of a perfect organism, chromosome functions are free to vary.

5. If a change in the expression of a character changes an essential relation between the organism and its environment, natural selection favors or retards variation according as the variation affects the relation to environment favorably or unfavorably (protective adaptation, for example).

6. Chromosome variation is limited by the constitution of the chromatin itself.

Organisms that reproduce asexually are freer to vary than others. An organism continuously propagated by cuttings may, by unrestrained variation of chromosome function, lose the power of sexual reproduction, *e. g.*, the banana plant. Presumably, variation is here so rapid as to secure the advantages ordinarily conferred by sexual reproduction.

Evolutionary changes may, in general, be accounted for as the result of slow, gradual changes in the functions of the chromosomes. It was shown, however, that bud variations are possibly marked changes in chromosome function due to a new adjustment between the constitution of chromatin and the food supply or other elements of the environment. Presumably, such changes are most likely to occur in forms propagated asexually, and especially when propagated under conditions of forced growth, where the food supply is abnormally large. Bud variations may possibly be correlated with changes in the numbers of chromosomes.

It was pointed out that a widely distributed species might present a series of forms, adjacent sections of which might differ so little as to interbreed freely, while the extremes, if they met, might not be able to interbreed at all.

In the discussion which followed Dr. O. F. Cook pointed out that the doctrine of the permanent identity of the chromosome has not been established, and that the indications of the more recent cytological research were against it. Mr. Spillman replied that a different interpretation might be placed upon the cytological phenomena cited by Dr. Cook.

In response to a question by Mr. M. B. Waite, whether the view set forth by Mr. Spillman, in addition to explaining geographical species, would not tend also to explain what a species is, Mr. Spillman replied that the theory formed important evidence on this question, stating that while specific distinctions differ in different groups and in the minds of different investigators, we might go so far as to say that two groups which can not interbreed must be distinct species. Even if they do not present morphological differences that will permit their identification variation will soon bring about such differences in the absence of interbreeding. On the other hand, the term species has acquired such a meaning that we can not state that two groups that can interbreeed are the same species. Inability to interbreed may be taken as the outer margin of the field of specific distinction.

Mr. Doolittle cited as examples analogous to that of the goldenrod referred to by Mr. Spillman (as a widely distributed group adjacent sections of which interbreed but extreme forms of which might not interbreed) certain species of rodents described by Dr. Merriam, and Dr. Stejneger mentioned two butcher birds (*Lanius*), subspecies in Central Asia which came together by different routes in the Scandinavian peninsula as separate species.

M. C. Marsh,
Secretary.

THE TORREY BOTANICAL CLUB.

The meeting of the club on November 13, 1906, was called to order by President Rusby

at 8:15 o'clock, at the American Museum of Natural History.

The following scientific program was presented:

Account of a Collecting Trip in the Adirondack and in the Catskill Mountains: Dr. PER AXEL RYDBERG.

Dr. Rydberg gave an account of botanical field studies and collecting in the regions mentioned, giving special attention to the blackberries. The talk was richly illustrated by herbarium specimens collected on the trip.

Remarks on the Flora of China: Dr. AUGUSTINE HENRY.

Dr. Henry gave a very interesting account of some features of the flora of China, pointing out its richness and great diversity, which are correlated with diversity of topography and climate, and emphasizing both the slight amount of collecting that has as yet been done there, and the important results to be obtained by ecological and systematic studies in that region. As an illustration of this he called attention to the fact that several genera, recorded in existing manuals as monotypic, are known to be represented in China by several distinct species.

THE club met on November 28, 1906, at the museum building of the New York Botanical Garden, at 3:30 P.M. In the absence of President Rusby, Dr. H. L. Lighthipe was called to the chair.

The following scientific program was presented:

Some Costa Rican Orchids: Mr. GEORGE V. NASH.

The speaker referred to the little known country of Costa Rica, and the desirability of securing material from there. Mr. Wm. R. Maxon, of the United States National Museum, during the early part of the year, made an exploration in this region in the interests of the New York Botanical Garden, and brought back with him, not only a valuable collection of herbarium material, but also a large collection of living plants, representing mainly the orchid, fern, bromeliad and cactus families. This material, owing to the care taken by Mr. Maxon in collecting and packing it, arrived in excellent condition. A great many orchids were among the lot, and several of these have already flowered, revealing new and interesting species. Living material is especially desirable in this family of plants, as the color and shape of the flowers play a large part in their classification, and these characters are difficult to determine from dried material. The genera *Pleurothallis, Elleanthus* and *Zygostates* have each already yielded one species new to science. The new species of *Zygostates* is a particularly interesting discovery, as it proves not only to be a species hitherto unknown, but also brings into the flora of North America a genus known formerly only from Brazil and Peru. Among other things worthy of note are: *Warscewiczella Wendlandii discolor,* originally described and known only from Costa Rica; *Maxillaria iridifolia,* found throughout tropical America, but certainly differing much in general appearance from the other members of the genus; and *Cycnoches Rossianum,* originally described from a plant which flowered in cultivation in the Garden of Mr. Ross, at Florence, Italy, in 1889. The origin of this plant was unknown, and it is now interesting to have its home revealed in this collection of Mr. Maxon's. The remarks were illustrated with living plants of the species referred to, supplemented with herbarium specimens, drawings and material preserved in formalin.

The Sedges of Jamaica: Dr. N. L. BRITTON.

Dr. Britton exhibited specimens of all species of Cyperaceæ known to occur on the island of Jamaica, including several species new to that island, collected by Professor Underwood, or by himself during a visit to Jamaica in the month of September. He remarked on the distribution of many of these species, and on the fact that a number of them are found in the West Indies only in Jamaica, their further distribution being Central America and South America. This distribution of these sedges is paralleled by that of a considerable number of species in

other families, so that the South American relationship of the Jamaica flora is more intimate than that of Cuba, Hayti or Porto Rico, and it is suspected that this may be an indication of a former land connection between Jamaica and the continent to the west or southwest. Dr. Britton's paper included a complete enumeration of the species now known, together with diagnostic keys for their determination and as much of their synonymy as relates to Jamaican records. No undescribed species were found, but the collections made by recent explorers added a number to those recorded by Mr. Clarke in his monograph of the West Indian Cyperaceæ, published in the second volume of Professor Urban's 'Symbolæ Antillanæ.'

Exhibition of Photomicrographs of North American Woods: Dr. C. Stuart Gager.

Numerous specimens were shown from a collection of photomicrographs of cross-sections of North American woods, recently acquired by the garden from Mr. James A. Weale, of the firm of Williams, Weale & Co., of Liverpool, England. These photomicrographs are all enlarged ten diameters, thus facilitating comparison. They are of very superior quality, so that many finer elements of the histology of the various woods can be demonstrated under a lens with nearly as great satisfaction as from the original sections. They possess the advantage of being less fragile than the sections themselves, and of serving better than they for purposes of demonstration before classes and otherwise. The collection contains representations of practically all North American species.

By way of comparison, specimens were shown of Hough's 'American Woods' and of Nördlinger's 'Holzquerschnitte.'

C. Stuart Gager,
Secretary.

The American Chemical Society. New York Section.

The second regular meeting of the session of 1906–7 was held at the Chemists' Club, 108 W. 55th St., on December 7. The present councilors, Messrs. Leo Baelkeland, F. D. Dodge, T. J. Parker, W. J. Schieffelin and Hugo Schweitzer, were reelected.

The following papers were presented:

A Necessary Modification of Volhard's Method for the Determination of Chlorides: M. A. Rosanoff and Arthur E. Hill.

The authors set forth the advantages of filtering off the insoluble silver chloride formed in the reaction demonstrating by experiment the indefinite end point obtained when this is not done. The subject awakened considerable discussion among several members present who had made many determinations by Volhard's method and who questioned the advantage of the modification.

The Color Change in Chromic Chloride Solutions: Arthur B. Lamb.

The speaker showed, by an experiment on the lecture table, that the change in color from green to violet of a solution of green chromium chloride was accelerated by adding a salt of a weak acid like acetic and greatly retarded by adding a strong acid as hydrochloric. The application of the principles of the ionic theory to this and related transformations was dealt with at some length. Attention was called to the explanation, afforded by this investigation, of some results by Weinland and Koch, showing the varying amount of chlorine precipitated from solutions of green chromium chloride by different silver salts.

Some New Double Phosphates: L. J. Cohen.

The properties of a number of salts of phosphoric acid were described and their analyses compared with the theoretical.

Note on a Strange Case of Poisoning: M. T. Bogert.

A case of poisoning in the distillation of certain bromine compounds, where deep destruction of tissue, with no apparent external injury, was caused by very brief contact of the hand with the vapors. Professor Bogert further spoke of the desirability of calling attention to injuries received in handling corrosive materials in order that suitable precautions might be taken by future investigators.

C. M. Joyce,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE TEACHING OF CRYSTALLOGRAPHY.

SEVERAL weeks ago Professor A. F. Rogers called attention through the columns of this journal[1] to a number of points concerning the teaching of crystallography, especially as a part of the work in an *elementary* course in mineralogy. In order to discuss Professor Rogers's paper, the end to be attained by such a course must be clearly understood. If the work in the *elementary* or *beginning* course has as its object the training of professional crystallographers much may be said in favor of a course similar to the one outlined by Professor Rogers. If, however, on the other hand, the course is to be only a part of the general education of the geologist, chemist, civil or mining engineer, forester, or teacher of science in the secondary school, the practical side of the work must be emphasized as much as possible. In such a course crystallography must, hence, be considered simply as a means to an end, that is, it should train the student in the rapid recognition of crystal forms. The handling of a large number of forms—models and crystals—tends to train the eye better than do extended discussions concerning the measurement, calculation, and projection of crystals.

The question which confronts most students of mineralogy—here it may be mentioned that in most institutions where mineralogy is taught at all only a very small percentage of the students have time to pursue more than the elementary course—is the rapid determination of minerals and, hence, theoretical considerations, which are of vital importance to the crystallographer, may in general be dispensed with. To be sure, some theory must be given, but all the theory necessary can be readily given by means of lectures and the laboratory work devoted entirely to the acquiring of a comprehensive knowledge of forms by contact and inspection rather than by analysis. (Formenanschauungsunterricht of von Groth.)

The writer agrees with Professor Rogers that the classification of crystal forms based upon symmetry is the best to use even with beginners, but would add that the older ideas of holohedrism, hemihedrism, etc., should—even though there be no structural connection between such forms—be retained on account of the many advantages they offer in acquiring a clear understanding of the forms possible in the various classes of symmetry. That these advantages are recognized as of considerable importance, it may be well to state that most of the German texts on crystallography, *designed for beginners*, retain them; among such works those of Bauer (1904), Bruhns (1904), Klockmann (1903), Linck (1896) and Naumann-Zirkel (1901) may be mentioned.

It is also common practise with German mineralogists to follow the older methods in the *elementary* course of instruction and treat the cubic or isometric system first and then the others in order. Even von Groth, who is no doubt one of the strongest advocates of the newer classification, retained to the knowledge of the writer, who was a student in his laboratory during the years 1899–1901, the older method of treatment (including holohedrism, hemihedrism, etc.!) in his beginning course rather than discuss the forms as outlined in his 'Physikalische Krystallographie,' the third edition of which had appeared several years before, namely, in 1895.[2] In fact Professor von Groth was accustomed to state in an introductory lecture that from the theoretical point of view the order as outlined by him—begin with class of lowest grade of symmetry and discard ideas of holohedrism and so forth—was the natural one to follow, but that certain practical and pedagogical reasons demanded that the reverse order be pursued especially when discussing crystallography with *beginners*.

There is no denying the fact that the measurement, calculation and projection of crystals are of great value to obtain a clear insight into the true meaning of crystallography and, hence, ought to be pursued by at least all

[1] N. S., Vol. XXIV., pp. 620–621.

[2] Compare Bruhns, 'Elemente der Krystallographie,' 1904, preface and foot-note on page 2. Also Baumhauer, 'Die Neuere Entwickelung der Krystallographie,' 1905, pp. 26–53.

graduate students in geology, chemistry and physics. But such work should follow the introductory course. In this advanced course a full treatment of the Miller indices, axial ratios, etc., finds its proper place. Would it not be the height of folly to recommend that extended philological researches be introduced into the beginning course of one of the modern languages? At any rate, Professor Rogers's statement that 'without something of the sort (meaning crystal measurement, calculation and drawing) the time given to crystallography may almost be a waste of time unless it is taken up at some future time' is to my mind altogether too sweeping and certainly needs qualification. I would like to ask what student of mineralogy has not found a course in elementary crystallography of the highest value and interest, even though it did not include the work supposed by Professor Rogers to be of paramount importance.

Edward H. Kraus.

Mineralogical Laboratory,
University of Michigan,
November 20, 1906.

CHAMBERLIN AND SALISBURY'S TEXT-BOOK OF GEOLOGY.

The review of the three-volume 'Text-book of Geology' by Professors Chamberlin and Salisbury in a recent number of Science, is likely to convey to the general reader an erroneous impression of that publication. Certain idiosyncrasies of style and little errors of detail, some of which are not real, are dwelt upon at such length that one becomes imbued with the idea that such mistakes are abundant and that they detract largely from the value of the text. It is natural that in a book of this size a number of things may be found worthy of criticism, and especially is this true of little matters which are likely to escape notice in reading the proof of the first edition. Mistakes of this class are better brought to the attention of the authors through the medium of a personal communication than by making them the subject of complaint in the public prints. Enough of such details can be found in any work to convey a wrong impression of the whole, if they are given so large a space that the main features of the work receive subordinate notice. It should be the function of a review to give the reader a correct understanding of the important and readable qualities of the book, whether they are good or otherwise, and not simply to recount trivialities. While in this case the reviewer finally gives adequate expression of his appreciation of the high value of the books concerned, this expression is prefaced by so many criticisms of details that the effect of his commendation is largely lost.

Some of the criticisms affect mere oversights in proof-reading, which are bound to occur in any publication of this magnitude. Several of these have been corrected in the second edition of volume I. Such an error was the use of 'syncline' for 'anticline' as pointed out by Dr. Branner.

A large number of the specific faults mentioned in the review are found on closer inspection to be imaginary rather than real, and one is forced to conclude that the reviewer was somewhat hasty in his perusal of the text. Of this nature is the criticism of the statement that "theoretically the rotation of the earth should increase erosion on the right bank of streams in the northern hemisphere and on the left bank in the southern," because "no reference is made to the direction of the streams," for this tendency is not dependent upon the direction of the streams, and the authors were correct in leaving their statement unqualified in this particular.

The reviewer takes exception to the statement that the advent of the Ammonites occurred in the Permian and cites Monograph XLII., U. S. G. S., as showing that they were abundant in the coal measures. The genera described in that work, however, belong to the types most widely known as Goniatites and Ceratites, the occurrence of which was duly mentioned by the authors. These are ammonoids, of course, but not Ammonites as the term is generally understood. The specific statements of the authors are therefore discriminative.

The statement of the authors that 'differences in density of sea water are due to differences in temperature and salinity' is criti-

cized on the ground that salt is not the only mineral in solution. Probably few students would understand 'salinity' to refer solely to common salt, since it is commonly used in its broader sense in scientific treatises.

It is a matter of surprise that Professor Branner should say that 'no mention is made of increase of temperature' in connection with the deposition of mineral matter from solution, for the influence of temperature on solution and deposition is distinctly recognized by the statement that 'reduction of temperature often causes deposition' with the added statement that 'in general, hot water is a better solvent of mineral matter than cold,' with the further recognition in a footnote (p. 213, 1) of exceptional cases, lime carbonate being specified. The statement might have been more fully explained, but doubtless the authors had in mind at all times the necessity of keeping the length of the treatise within reasonable limits.

The reviewer makes the authors affirm that 'the deposition of mineral matter from boiling water is the same process as that by which it is deposited upon evaporation.' The statement in the text is that 'the process of deposition by evaporation is illustrated when water is boiled,' which is obviously true. The statement might have been made clearer by amplification; yet there is no reason to give the abbreviated statement an adverse interpretation.

Complaint is also made that 'in discussing river terraces' (p. 198) 'no mention is made of a stream swinging back and forth across its flood plain.' On the page cited only the exceptional modes of terrace-formation are outlined, whereas if the reviewer had glanced at pp. 196–197 he would have found the normal process of terrace-making fully discussed.

Another group of criticisms is based upon misinterpretation of the text, where the true meaning is obvious upon careful reading. Perhaps the authors might have explained their statements, so as to forestall all possible misinterpretations, thus increasing the size of the volumes, but no doubt it was expected that the student would find the correct interpretation from briefer statements which were sometimes capable of being twisted into another meaning.

With reference to the statement that 'faults rarely show themselves in the topography of the surface' the reviewer says that 'a California geologist could hardly be expected to uphold such a statement with a straight face.' The original sentence is 'since faults rarely show themselves in the topography of the surface, their detection and measurement are usually based on the study of the relations of the beds involved.' Topographic features which are known from other evidences to have arisen from faulting, but which could not be proved to have originated in that way except by the other means indicated, are clearly not embraced in the statement. On a previous page, fault scarps are discussed and the fact stated that they are, before they become obscured by erosion, notable topographic features. While it is unquestionably true that in some parts of the world recent fault scarps are still prominent, it may also be affirmed without hesitation that the vast majority of faults have no topographic expression.

In discussing the formation of deltas, the statement is made in the text that 'the projected stream current is ineffective, all load except that in suspension is dropped and a depositional slope is established.' The reviewer assumes that matter in solution is meant, whereas obviously the material rolled or pushed along the bottom is referred to. This is clearly implied by the context, for a little below it is stated that 'the finest sediment will be carried beyond the steep slope and conform to the topography of the bottom beyond.' The wording of the sentences could have been improved and has been so altered in the second edition of volume I., which the reviewer seems not to have had before him.

The criticism of the authors' statement with reference to fiords is hardly deserved, since subsidence is explicitly recognized as a factor in fiord-making in several places in the volumes. On the particular page cited the question of the effect of glaciation in the development of fiords was the special case under discussion.

Most of the above criticisms relate to small

matters, but the following touches one of much importance. The reviewer says that the reasons are not clear for the inference that 'a vegetal covering of the land extended as far back in the history of the earth as clay slates, quartzose sandstones and limestones formed the prevailing sediments.' He proceeds to give reasons for thinking that decomposition and the deposition of limestone may take place without the aid of vegetation, overlooking the meaning of the phrase 'the *prevailing* sediments,' and that of the context, in which it is stated that "if the surface be bare of vegetation, the crystalline rocks are usually disaggregated before they are decomposed, since destructive action occurs best at the junctions of crystals and along cleavage lines and hence the crystals are usually separated from one another before they are fully decomposed. In the absence of a covering to hold them in place until they are decomposed they are apt to be washed away, and the resulting deposit consists in considerable part of grains of feldspar, mica, hornblende and other minerals which do not usually occur in well decomposed sediments." It is difficult to see how a careful student can fail to note that there is here a recognition of decomposition, on a small scale, independent of vegetation. The point to be emphasized was, on the other hand, that in the absence of the protection of a vegetal covering mechanical disintegration so far overpowers decomposition that in most cases the disaggregated particles on the naked surface are carried away by erosion, and give rise to a formation which is only partially decomposed. When, therefore, the 'prevailing formations'—not exceptional or possible ones—consist of the products of *mature decomposition* (II., p. 199, where the matter is again stated) it is reasonable to suppose that the land possessed a vegetal covering.

The authors are scored for not treating the Pacific coast geology of Mesozoic and Tertiary times more fully. It may be that they would reply that it is because relatively few good sections of the strata of the Pacific coast have been published. Nevertheless, sections from that part of the country, illustrating the systems referred to appear as figures on no less than twelve pages in volume III. and additional columns are furnished at the close of that volume. These sections receive as much consideration in an interpretative way as one could expect in a treatise so cosmopolitan in its field. Not improbably the geologists of Dakota think that the geology of Dakota has not received adequate recognition, while the geologists of Texas have the same feeling with reference to the geology of their state, and so on indefinitely. It is but natural that those regions which have been most thoroughly investigated should receive the largest share of attention.

It is in view of such points as these that the reviewer takes occasion to say that 'these are oversights which must annoy teachers of geology.' It is the present writer's observation, in using these volumes as a text-book with students, that the number of misinterpretations put upon the text is extremely small; and while teachers of geology may regret any and every imperfection in the volumes they may well be gratified that so complete and readable a treatise is now available.

Eliot Blackwelder.

University of Wisconsin,
November 7, 1906.

The Determination of the Types of Genera. A Correction.

In my recent article on the 'Determination of the Types of Genera"[1] the sentence,[2] "As *gryphus* was the last species removed from the genus *Vultur* it is its type by elimination * * *," requires modification. In reality *gryphus* was the second species removed from the genus, but the last species to be disposed of by assignment to a special genus of its own, which is the statement intended. From the modern standpoint, no two of the original six species of *Vultur* were congeneric, and *gryphus* was the last species to be provided with a distinctive generic name.

J. A. Allen.

[1] "The 'Elimination' and 'First Species' Methods of Fixing the Types of Genera," Science, N. S., Vol. XXIV., No. 624, pp. 773–779, November 14, 1906.

[2] Page 776, at middle of first column.

SPECIAL ARTICLES.

CHARACTER OF THE BACTERIAL FLORA OF CARNIVOROUS AND OF HERBIVOROUS ANIMALS.

IN the course of the study of anaerobes of the human intestine it appeared desirable to learn something about the characters of the bacterial flora inhabiting the large intestine of various domestic and wild animals. It was noticed that in the dog, which is frequently exclusively carnivorous, the intestinal contents often showed the presence of large numbers of spores, spore-bearing bacilli and vegetative forms of anaerobes. The numbers present in the feces were noted to be especially large in some animals which had been exclusively fed on meat. A study of a grown cat fed upon raw meat showed the presence of Gram-positive vegetative anaerobes from one end of the digestive tract to the other. Flora derived from the stomach, small intestine and large intestine were inoculated and grown in bouillon flasks and showed an abundant production of methyl mercaptan as well as hydrogen sulphide. The numbers of colon bacilli present in this case were relatively small as compared with the anaerobes. The study of the colonies obtained on anaerobic plates showed that a large portion of the organisms present in the intestinal tract were *B. aerogenes capsulatus*. Intravenous infusion of these organisms into a rabbit which was afterwards killed and incubated showed in a high degree the typical gas-formation.[1]

Observations on other cats showed the presence of considerable numbers of spore-holding bacilli and free spores, sometimes in chains, in addition to vegetative forms of anaerobes. The position of these spores and spore-holding bacilli has not been established in a bacteriological sense. Observations were also made upon the intestinal contents of the wolf, tiger and lion. Several different tigers were studied and the observations were not confined to the examination of one lion and one wolf. The material from the lion showed the presence of many free spores. It also showed the presence of considerable numbers of Gram-positive bacilli, suggesting *B. aerogenes capsulatus*. Gram-stained preparations from wolves showed findings similar to those observed in the lion except that the spore-holding bacilli were more numerous. The findings in the case of supposedly healthy tigers were not essentially different from those in the case of the wolf and lion. In the case of one tiger, suffering from osteomalacia, greatly impaired nutrition and loss of strength, the microscopical fields derived from several different samples of feces revealed the presence of immense numbers of free spores and smaller numbers of immature Gram-negative spore-holding bacilli. These spores developed into organisms which possessed all the generally known cultural and biochemical characters of *B. aerogenes capsulatus*, including the ability to develop a high grade of gas-formation in rabbits injected and incubated.

It was found that bouillon cultures of the mixed fecal flora from the lion, tiger, wolf and cat all developed quickly a sufficient quantity of methyl mercaptan to give promptly a very well developed reaction with isatin-sulphuric-acid.

Experiments were made with the mixed fecal flora from these carnivorous animals to determine their pathogenicity when injected into the subcutaneous connective tissue. It would have been better to have worked with pure cultures of the anaerobes in question, but opportunity has not yet arisen to isolate them. The result of the inoculations into guinea-pigs was the same in each instance. The animals died within twenty-four hours and usually in fifteen to eighteen hours. At autopsy the subcutaneous connective tissues

[1] The incubation method of Welch and Nuttall is based on their observation that the gas bacillus produces gas abundantly in the blood, organs and tissues of rabbits killed a few minutes after intravenous injection. Here the blood and tissues of the rabbit act as a peculiarly favorable culture medium for the growth of the gas bacillus, the latter having been thoroughly spread by the blood through the body, and the conditions being anærobic. A suspension of the feces to be tested is prepared by grinding 1 gram of the fresh material with 9 c.c. of 0.85 per cent. salt solution and filtering through absorbent cotton. One or two cubic centimeters of this suspension are then injected intravenously into a rabbit which is quickly killed and incubated for five hours at 70°C.

were hemorrhagic, œdematous and showed necrotic changes which extended in some instances to the muscles. Gas-formation was not usually noted as a prominent feature. These pathological alterations were not confined to the site of inoculation but had extended to the subcutaneous connective tissues throughout the body and were especially pronounced in the axillæ and in the groin. It is unnecessary to enter here into the details as to the character of the organisms recovered from these lesions.

We may contrast with these findings the observations made upon herbivorous animals, including the buffalo, goat, horse, elephant and camel. In the case of the camel, elephant and horse the preponderant bacteria in the Gram-stained fields were small Gram-negative organisms which were regarded as special forms of *B. coli*. In the case of the goat the fields contained some Gram-positive bacteria and of the Gram-negative ones a considerable number were of considerably greater length than the dominant small forms which were regarded as belonging in the class of colon bacilli. In the case of the buffalo, mixed fields were found as regards the Gram-staining and many of the positive organisms were found to be small diplococci and small bacilli. In none of these animals were seen any organisms suggesting *B. aerogenes capsulatus* excepting in the case of the buffalo where the number of bacilli of this type was very small. Spore-holding organisms were not observed, but moderate numbers of free spores were noticed in all the fields except those from the elephant. In the fields showing the largest number of spores their occurrence was far less frequent than in the lion, tiger, wolf or cat.

The mixed flora of these different herbivorous animals, grown upon peptone bouillon, failed to show the production of methyl mercaptan excepting in the case of the horse, where a moderate reaction was obtained.

Observations were also made upon the effect of suspensions of the mixed flora from herbivorous animals when injected subcutaneously. The quantities of suspension used were usually about twice as great as in the case of the suspensions from the carnivorous animals. With the exception of the suspensions obtained from the horse, the pathogenicity of these suspensions was found to be slight, the guinea-pigs frequently living two or three days or entirely recovering. In the horse were found hemorrhagic and œdematous lesions with necrosis, similar to those found in the carnivorous animals. These lesions were, however, less pronounced than in the case of the suspensions from the carnivorous animals. In the case of the elephant a considerable quantity of fibrinous exudate was found about the point of inoculation. No œdema or necrotic change was observed in the subcutaneous tissues.

A further confirmation of the radical differences existing in the intestinal tracts of carnivora and herbivora is furnished by a series of observations with the Welch-Nuttall incubation test. Suspensions were made from the feces of all the types of animals mentioned and equal quantities of these suspensions were infused intravenously into a series of living rabbits. The rabbits were then quickly killed and incubated. On examination after twenty-four hours it was found that all the rabbits infused with suspensions from carnivora showed in an extreme degree the characteristic putrefactive changes in the liver, cellular tissues, etc., induced by pure cultures of *B. aerogenes capsulatus* or of the bacillus of symptomatic anthrax. The rabbits infused with suspensions made from the feces of the herbivora showed similar but very much slighter changes in each case. The results for each group of animals separated the herbivora sharply from the carnivora. Examination of the livers showed the number of bacteria in the carnivorous series to be many times greater than in the herbivorous series. The microorganisms were regarded as being almost certainly *B. aerogenes capsulatus* on account of their morphology and failure to sporulate. The bacilli of symptomatic anthrax readily sporulate in the incubated rabbits. The gas-bacillus (*B. aerogenes capsulatus*) does not sporulate under these circumstances.

These differences in the appearance and behavior of the bacteria derived from typical

carnivora and herbivora suggest that the habit of living upon a diet consisting exclusively of raw meat entails differences in the types of bacteria that characterize the contents of the large intestine. The occurrence of considerable numbers of spore-bearing organisms in the carnivora points to the presence of anaerobic putrefactive forms in great numbers. The results of subcutaneous inoculations into guinea-pigs bear out this view and indicate that the numbers of organisms capable of producing a hemorrhagic œdema with tissue necrosis, with or without gas-production, are very considerable. Unfortunately, the data pertaining to the biological properties of these pathogenic anaerobes are at present insufficient to permit us to classify them or to say more of their nature than that they are organisms representative of a definite group of putrefactive anaerobes which make butyric acid and hydrogen and exert a peptonizing action upon living tissues. Nevertheless, the observations here recorded are of much interest in relation to the bacterial processes and nutrition of herbivorous[2] as distinguished from carnivorous animals and are significant furthermore for the interpretation of bacterial conditions found in man. The question arises whether the abundant use of meat over a long period of time may not favor the development of much larger numbers of spore-bearing putrefactive anaerobes in the intestinal tract than would be the case were a different type of proteid substituted for meat.

Inquiries made of Dr. Blair, the pathologist at the New York Zoological Park, elicited the fact that while, upon the whole, the carnivorous animals are apt to live somewhat longer than the herbivorous animals of about equal size, the carnivora are much more likely to develop conditions of advanced anæmia in the later years of their lives than is the case with the herbivora. Dr. Blair states that it is usual in the later years of life for the carnivora to show a much diminished volume of blood and at least a moderate fall in the hemoglobin. Instances are stated to be not uncommon in which a pernicious type of anæmia has developed in the carnivora. On the contrary, among the herbivora it is said that pronounced anæmias are very occasional. The examples of severe anæmia encountered among the herbivora were said by Dr. Blair to be in nearly all instances referable to gross animal parasites.

The information now available indicates that man occupies a position between the herbivora and carnivora with respect to the numbers of putrefactive anaerobes that are present in the digestive tract and their proportion to the total number of bacteria. The influence of a purely vegetable diet on the one hand and of a strict meat diet on the other, upon these anaerobes, is much in need of careful investigation.

C. A. HERTER.

[2] Many of the herbivora yielded mixed flora incapable of making gas on dextrose bouillon.

THE EXCEPTIONAL NATURE AND GENESIS OF THE MISSISSIPPI DELTA.

AT the December meeting of the Cordilleran Section of the American Geological Society, 1905, I read a paper under the above title, an abstract of which, printed on the program, is copied below:

This paper discusses the wholly exceptional materials and form of the lower delta of the Mississippi river, as observed by the writer in 1867 and 1869, and described and discussed in the *American Journal of Science* in 1871. Following out the suggestions of Lyell, and the disputed statement of Humphreys and Abbott that the alluvial deposits of the great river are only of slight depth, the writer investigated the extreme mouths of the Passes, the 'Neck' and the similar minor, bird-foot-like arms projecting beyond. It became apparent that the silty river deposit on these narrow dikes or banks is only superficial, and that their resistance to erosion during overflows is due to their being mainly composed of tough, inerodable 'mudlump clay.' That these mudlumps, observed and described by Lyell, are upheavals of the river bottom, and are formed of such clay as is deposited *outside* of the bar, where the turbid water of the river meets, and is clarified by, the saline sea water. Also, that the mudlump upheavals occur in the *main* outlets or passes of the river, as a direct result of their being the main outlets. No mudlumps then existed in the South Pass, but now that it has been artificially made the main channel, mudlump upheaval has taken, and is taking, place. Mudlump formation is thus

the normal mode of progression of the delta of the main Mississippi.

No such phenomena are known to occur in any other river of the world, hence no other river has such birdfoot mouths. The Mississippi delta should not, therefore, be longer presented as the type of a normal delta, as is done by Russell in his 'Rivers of North America.'

The above paper was not written out for publication, as I then thought it sufficient to have called the attention of geologists to the omission of so exceptional and unique a feature, already elaborately discussed by Sir Charles Lyell in the tenth edition of his 'Elements' (pp. 448–454), and belonging to the principal river of North America. I find the same misconception and omission, however, in Chamberlin and Salisbury's 'Handbook of Geology'; hence it seems desirable to call attention more pointedly, as was suggested to me by Russell, shortly before his death.

Upon the 'correction' of the mouths of the great river, rendered necessary by the peculiar phenomenon of the mudlumps, the government has in the past been obliged to spend many millions. It is still compelled to keep dredgers constantly at work, notwithstanding the fact that the enormous volume of the river has been turned into the single channel of the 'south pass' of the delta. Why does not the scouring action of the current keep this channel permanently open, once for all? And why does not the river, in its twice-annual overflows, break and wash permanent lateral channels through the narrow barriers or levees that jut out into the gulf in birdfoot shape, unlike all other deltas in the world?

A simple examination of the material of which the banks of the 'passes' and of the uprising mudlumps in the channels are composed, answers these questions categorically. The material in both cases is a tough clay, wholly unlike any of the visible sediment carried by the stream; the latter forms only a thin surface layer on the main clay mass bordering and confining the currents of the river, whose scouring action is powerless so long as the clay remains permanently submerged.

Whence this clay, and why should it be brought up forcibly from the channel of the river, of all places the one where the scouring should be most effectively done?

Of this forcing-up there can be no question whatever. Pilots and ship-captains have seen the channel in which they passed to sea a short time before, completely blocked by a mass of tough clay on their return. A ship thus run aground in several feet of water in the evening has found its bow raised out of the water in the morning, requiring several tugs to pull it off backward. For years, tugs with gigantic engines pulled the entering and the sea-going ships through the tough mud, which all the dredging and artificial scouring done by the U. S. River Service could not control. Frequently the mud kept rising as fast as the dredger worked.

Soundings around newly risen mudlumps, and sometimes direct inspection, generally show them to have the form of a rounded bubble, from whose highest point there frequently issue gas bubbles, and sometimes a flow of liquid mud visible even below water. Gas bubbles were also noted whenever the dredgers disturbed a lump in the channel.

When a mudlump rises above tide level, as is frequently the case, there are usually formed on its summit one or several vents, like the craters of mud volcanoes, from which there issues a steady flow of semi-fluid mud, agitated from time to time by gas bubbles; the gas is combustible and, as ascertained by the writer, is such a mixture of marsh gas and carbonic dioxid as is evolved from organic débris in their *first* stages of decay. This gas is undoubtedly derived from the large masses of trees and other vegetable matter carried and buried by the river in its deposits. But its amount, as Lyell correctly estimated, is wholly inadequate to account for the copious and steady flow of fluid mud, which gradually builds up flat cones of solidified material, sometimes attaining the height of fifteen to eighteen feet above tidewater, but more commonly six to ten feet. Usually other craters are formed before the extreme height is reached; or several mud-bubbles coalescing may form a small island with several vents.

The latter in the end are usually choked by solidified mud; and so soon as this happens the work of destruction begins. Sometimes the lump collapses bodily, segments of circular fissures forming all over it, often leaving a small lagoon in the middle; this occurs especially where the material is not a very stiff clay, as in the southwest pass. On the eastern portions of the birdfoot area the destruction of the lumps usually occurs by the waves washing over the *dried* mud of the cones, and bringing it down, to be partly washed away, partly deposited in the intervals between adjacent lumps, connecting them and thus gradually forming a solid, continuous clay dam, on which the river current exerts no sensible eroding effects while it remains submerged.

It is in this way that the narrow bands that bound the outer passes of the Mississippi are formed and maintained, and are made to progress seaward. In other words, *mudlump formation is at present the normal mode of progression of the visible delta into the gulf.*

How far back in time or distance this mode of progression reaches is, of course, unknown at present; but the peculiar, onion-like structure of mudlumps that have risen above the surface and become mud volcanoes, should render this not a difficult problem to solve where sections exist or shall be made within the delta. The peculiar material, so different from any now deposited by the river above its mouth, and which in fact can only have been deposited in slack-water, is enough to distinguish the mudlump formation. It is this same clay that has for ages withstood the impact of the main river-current at the 'head of the passes,' whence the several outlets diverge; the same material forms the narrow banks of the 'neck,' at the head of which, where it diverges from the main delta-mass, forts Jackson and St. Philip are located. Were it otherwise, the narrow barrier separating the neck from Garden-island Bay could not have survived a dozen years of floods; whereas even the channels purposely cut through it by duck-hunters to avoid the long détour through the passes into the bays, have hardly been enlarged in fifty years.

If any more evidence were needed, it is supplied by the existence of an active mud-volcano in the marsh, seven miles above the mouth of the southwest pass, where the writer saw it spouting mudspatters and emitting mudstreams in 1869. This mudlump (then known as Morgan's lump) projected at least eight feet above the tall rushes (*Scirpus lacustris*), and rose, therefore, at least sixteen feet above the level of the marsh.

Sir Charles Lyell ('Elements,' etc., tenth edition, p. 452) inclines to carry the mudlump-genesis of the delta as far up as New Orleans, from information given him by Col. Sidell, of the River Service, U. S. Topographical Engineers. It should not be difficult to verify this in excavations made at New Orleans; mere borings can not, of course, determine the question.

As to the origin of the mudlumps, Lyell (*loc. cit.*) considers them to be formed on the principle of the 'creeps' so familiar to engineers and miners; he justly ascribes only a secondary part to the gases brought up with the mud, which according to my measurements amount to only one twentieth to one thirtieth of the volume of the material ejected. Lyell says: "The initiatory power may probably be derived from the downward pressure of the gravel, sand and sediment accumulated during the flood season off the various mouths or passes, upon a yielding bottom of fine mud and sand; materials which, as being very fine and impalpable, had long before been carried out farthest from the land." The great mass of river sediment "may well be conceived to exert a downward pressure capable of displacing, squeezing, and forcing up laterally, some parts of the adjoining bottom of the gulf, so as to give rise to new shoals and islands."

There can be no question of the general correctness of Lyell's explanation of this phenomenon, which certainly constitutes the most gigantic example of creep known, and as such should concern the geologist quite as much as the engineer. For why should the Mississippi, of all rivers in the world, *alone* exhibit this remarkable feature and mode of progression? and how, in view of the known average annual progression of the delta into the gulf (338

feet) shall we account for the continued existence of a fluid mud-layer for more than a century, in the case of Morgan's lump—why has not this mud been squeeezed dry into a sheet of clay long ago?

In my view, the entire phenomenon rests upon and is conditioned by the existence of the 'blue delta clay' and 'blue clay bottom' long commented on respectively by the engineers in charge of the river work, and the pilots off the Mississippi mouths. This blue clay constitutes a shelf reaching out about twenty-eight miles beyond the present mouths, where there is a steep descent into deep water. Wherever this clay is exposed along the gulf shore, it contains cypress stumps and other vestiges of swamp origin. It constitutes the main body of the formation which in my Mississippi report of 1860 is doubtfully designated as Coast Pliocene, but to which subsequently, finding it most characteristically developed at Port Hudson, I gave the latter name. Its existence and nature imply that swamp or marsh conditions prevailed to gulfward for nearly thirty miles beyond the present coast line, prior to the advent of the Mississippi River of to-day. Since that time the land has been depressed and reelevated to the extent of some 450 feet at least; but a prior elevation, indicated by stream-gravel beds now 450 feet below sea-level, must have thrown the Mississippi Valley drainage northward toward the Arctic, the divide between the two drainages being very low. This former northward direction of the drainage has been discussed somewhat widely before, by Tight and others, but not, so far as I know, with special reference to the gulf datum-plane and its bordering formations. The lower Mississippi River of to-day is evidently a very 'young' stream.

However that may be, the blue-clay shelf is there, and is practically water-tight and proof against erosion so long as it remains submerged and no gravel is carried by the current. It is in this respect much like the mudlump clay itself. It is constantly found by the sounding-lead outside of the river bar; but before reaching it the lead sinks slowly for some distance in a semifluid mud, which is undistinguishable from that flowing from the mudlump vents. It is manifestly the result of the precipitation of the finest clay and silt when the river water mixes with that of the sea.

In its annual advance of 338 feet to seaward, the sandy bar-material covers this fluid clay much faster than the latter can escape to seaward under the pressure. It is covered by the heavy bar-sand, which from a boat in the shallow water over the bar-crest can be seen being carried rapidly over, shallowing the water outside; while *the deepest water inside the bar is found near the base of its landward slope.* And it is just there, *i. e.*, just *inside* the bar, and not, as Lyell seems to imply, on 'the adjoining bottom of the gulf,' that the rise of mudlumps chiefly takes place; right where the strongest current seems to indicate the best channel for ships to pass. In other words, the current *excavates* the river bed immediately inside the bar, and, relieving the superincumbent pressure, thus enables the mud-bubbles to rise.

It is not clear whether Lyell considers the bar as such to exert the pressure causing the rise; it is, at any rate, difficult to see how the static pressure of a *submerged* bar could cause the same material to rise from ten to fifteen feet above tide-level.[1] But there is no doubt that the weight and wide base of the bar is able to materially obstruct, if not prevent, the squeezing of the semi-fluid mud to seaward, despite a considerable *vis-a-tergo* from landward.

Given a semi-fluid layer of mud on an impervious clay bottom, reaching as far landward as Morgan's lump at least, the source of pressure is not far to seek. The sediment annually deposited on the marsh areas above, with their heavy growth of rushes and other aquatic vegetation, supplies ample weight; and the statement of the pilots that the mudlump springs always become more active when these marshes are overflowed, adds cogency to this explanation. *The vis-a-tergo is the ever-increasing weight of the river-sediments*

[1] The specific gravity of the outflowing mud ranges from a minimum of 1.25 to as much as 1.75.

proper, deposited in the marshes above during the twice-annually recurring floods of the great river.

Among the details of the investigation, given in my article above referred to, the following are of interest as corroborative of the above explanation of mudlump phenomena. The microscopic character of the ejected *mud* is precisely that of the mud brought up by the sounding-lead from the seaward slope of the river bar. There is a mixture of fresh-water organisms and débris with marine forms such as foraminifera; but these in the mudlump ejecta are in a macerated condition. The *water* accompanying the outflowing mud, or sometimes welling up clear from old or sandy vents, shows the chemical nature of diluted sea-water subjected to maceration with decaying organic matter. That is to say, its sulphates have been reduced to iron pyrites, which is scattered in shining crystals through the mud, while the water is strongly impregnated with bicarbonates of lime, magnesia and iron, so that it turns turbid on exposure to the air. Taking the common salt as the basis of comparison, the proportion of magnesium chlorid is increased, that of potash decreased; the latter doubtless by the absorption of the base into zeolithic combination.

The *gas* from a vent on the Passe à l'Outre consisted of 86.20 per cent. of marsh gas, 9.41 of carbonic dioxid, and 4.39 of nitrogen. This approximates closely to the average composition of the gas from ordinary swamps. No oxygen was present.

The commercial importance of the formation of mudlumps is well illustrated in the history of the several outlets or passes during historic times. The earliest navigation from the gulf to New Orleans was almost wholly through the 'Passe à l'Outre,' the most northerly of the mouths, whose very name indicates its chief importance as the outlet for deep-sea vessels destined for 'outre-mer'; with the northeast pass, it remained the main outlet in use even to the first third of the past century. Then it became so contracted and shallowed by mudlumps that the northeast and southeast passes were for a while the main channels used by vessels; but these also being soon heavily obstructed by lumps, and the south pass being too narrow and shallow for deep-sea ships, the southwest pass was, during the greater part of the past century, the main outlet for navigation. Its channel being very wide and its deposits more sandy by reason of its being most nearly in line with the main river at the head of the passes, its use involved the additional difficulty of shifting sand bars. To keep a navigable channel through these and the copious mudlump formations was an endless task, and cost the government millions; besides necessitating the use of enormously powerful tugs for the shipping. After many unsuccessful attempts for permanent relief, all of which were frustrated by the rise of mudlumps, came Eads's proposition to turn the river into the south pass, the mouth of which was then free from mudlumps. While this matter was before congress, the writer called Eads's attention to the almost certainty that whenever the south pass should be made the main outlet, mudlump upheaval would surely occur. Eads replied that he hoped that the increased velocity of the current in the narrow channel inclosed by his jetties would keep it scoured out to a much greater extent than the shallow southwest pass had been, and that at any rate it should be tried as an *ultima ratio,* and allowed to go unchallenged. To this, of course, I agreed.

The event has in the end justified both Eads's and my anticipation. Not many years after the completion of the jetties and wing-dams, mudlump upheaval began inside of the south pass bar; but the watchful activity of dredgers, together with the scouring action of the full river current, are successfully keeping the channel in navigable condition, at very much less current expense, and much more effectually, than could ever be accomplished in the southwest pass.

Taken altogether, these unique phenomena characterizing the formation and progression of the Mississippi delta seem to be of sufficient importance, both theoretical and practical, to render their omission from handbooks of American geology and hydrology hardly excusable. It is expected of those who write such treatises that they should acquaint them-

selves with all previous literature on the same subjects; but notwithstanding the elaborate bibliographies now so commonly appended to papers on special topics, the crediting and utilization of the more remote publications seems in danger of falling into innocuous desuetude.

E. W. Hilgard.
University of California,
December, 1906.

CURRENT NOTES ON METEOROLOGY.

BLUE HILL OBSERVATORY.

Vol. LVIII., Part II., of the *Annals of the Harvard College Observatory* contains 'Observations and Investigations made at the Blue Hill Meteorological Observatory in the Years 1903 and 1904.' From the introduction we learn that Mr. H. H. Clayton, well known as one of the foremost meteorological investigators in the world, has completed twenty years of service at Blue Hill, and that Mr. S. P. Fergusson, who, by his skill as a mechanician and his general ability along many lines of meteorological inquiry has contributed largely to the success of the Blue Hill work, has completed eighteen years of service. The introduction also contains a review of the principal work done at Blue Hill in the twenty years since its opening, but as readers of Science are familiar with much of this, we do not summarize here. Mr. A. Lawrence Rotch, the founder of the observatory, without whose untiring devotion to his science and unfailing readiness to assume the increasing financial burden of maintaining this institution the United States would occupy a far less prominent place in meteorological advancement, may well look back on the past twenty years of work at Blue Hill with pride and satisfaction. American men of science can have but one hope and wish in connection with the Blue Hill Observatory: that its next twenty years may be as fruitful in results as the last twenty have been.

THUNDER-STORMS AND THE MOON.

Much time has been spent by various investigators in the attempt to show some relation between the occurrence of thunder-storms and the phases of the moon. The latest contribution to this discussion comes from C. W. Hissink, of Zutphen, who in the September number of 'Hemel en Dampkring' presents the results of a study of thunderstorm days in Holland for the period 1883–1903. The means for these years show so complete an agreement for different phases of the moon that there can be no question that no lunar influence is shown. Evidently the supposed connection between moon and thunder-storms depends for the results obtained upon the period which any investigator uses, and upon the length of the series of observations. When a long series of observations is available, no lunar influence is, on the whole, manifest.

LANTERN SLIDES ILLUSTRATING CLIMATE.

We note the publication, by the Diagram Company, of New Malden, Surrey, England, of the seventh issue of 'The Diagram Series,' designed by B. B. Dickinson, assistant master at Rugby, and A. W. Andrews, extension lecturer. This series comprises a considerable number of lantern slides illustrating the climate of the world as a whole, and of the separate continents. Among these we observe charts of isotherms, isobars, winds, ocean currents and rainfall. It is encouraging to see the rapid increase in the demand for such teaching materials in meteorology and climatology for use in colleges and schools.

R. DeC. Ward.

NOTES ON ENTOMOLOGY.

A most interesting and attractive paper is that of Arnold Pictet,[1] on the influence of food and humidity on Lepidoptera. A great number of experiments were made by the author on the larvæ of twenty-one different species of Lepidoptera, among them the gipsy and brown-tail moths. His results show that changing the usual food is apt to cause variation in adults. A food difficult of assimilation hinders the growth of the caterpillar and lengthens larval life; in consequence the pupal

[1] 'Influence de l'alimentation et de l'humidité sur la variation des papillons,' *Mém. Soc. Physique et d'Hist. Nat. de Geneve*, Vol. 35, pp. 45–127, 4 pl., 1905.

period is shorter and there is a scarcity of pigment at emergence, resulting in a more or less albinic specimen. Insufficience of the normal food will produce the same result. On the contrary, abundant and rich food shortens larval life, lengthening the pupal period, so that there is an abundance of pigment, and a highly colored or melanic specimen appears at emergence. Color varieties of larvæ are often associated, but not always, with color varieties of the adults. Some caterpillars feeding on the same food may be either brown or green. The development of secondary sexual characters is also influenced by the kind and abundance of food. He finds that the size of the adult is proportioned to the size of the caterpillar; and that males vary more than females. Varieties produced by feeding increase in intensity and distinctness at each generation on the same food; however, there is always some tendency to revert to the normal form. Humidity in larval life is a partial factor in melanism, but much depends upon the temperature of the humidity and the time of its application. In some cases of cold humidity paler and more spotted forms were produced in a rather dark butterfly. The variation from humidity appears mostly on the front wings, and melanism usually starts along veins. Four fine plates illustrate the results of his experiments.

Dr. O. M. Reuter has presented an important work on the classification of the Hemipterous family Capsidæ.[2] The author, who has spent much of his life studying this one family, gives a long historical, critical and constructive account of the classification of these plant-bugs. He devotes considerable attention to a criticism of Mr. Distant's work on this family. After an examination of the structures most useful for genera and higher groups, he divides the family into twenty 'divisions,' or tribes, an elaboration of his previous classification, in the 'Hemiptera Gymnocerata Europæa.' He finds the best characters for the divisions in the pronotal carina, the cell of the wing-membrane, the tarsal joints, and especially in the arolia of the claws. Genera are based largely on shape of the head and the antennæ. Following this there is a phylogeny of the family, and a 'tree' to illustrate his views.

Dr. Walter Rothschild and Karl Jordan have published a revision of the American swallow-tail butterflies.[3] It is based on the collections in the Tring Museum and that of Oberthür. Full references and synonomy are given for all species and varieties. There are descriptions of some new species and many new subspecies, mostly from South America and the West Indies. Three new names are given to forms from the United States: *P. thoas* subsp. *autocles* from Texas; *P. glaucus* subsp. *canadensis* from Canada and Newfoundland; and *P. marcellus* subsp. *lecontei*, from various parts of the United States, to replace the *P. ajax marcellus* of Edwards, the true *marcellus* applying to the *P. ajax walshi* of Edwards.

The second report of the Wellcome Research Laboratories at the Gordon Memorial College, Khartoum, Egypt, 1906, contains a number of interesting papers. Theobald makes an additional report on the mosquitoes of the Sudan. He gives also notes on the 'maggot fly' (*Bengalia depressa*), the larvæ of which live under the skin of man, and other animals; also notes on the 'Congo-floor-maggot' (*Auchmeromyia luteola*), the larvæ of which crawl at night from crevices in the floor to suck blood from sleeping persons. He also gives notes on some stingless bees, a new pupiparous fly from the ibex, some Sudanese Hippoboscidæ, a melon fruit-fly (*Dacus* sp.), and on the Dura plant-bug (*Lygæus militaris*). Mr. E. E. Austen treats of several blood-sucking Diptera, describes two new species of Tabanidæ, and gives notes on various other species.

A little-known phase of entomology is touched by K. Leinemann in his article on the number of facets in the eyes of insects.[4] He

[2] 'Die Klassifikation der Capsiden,' *Festschrift für Palmén*, No. 1, Helsingfors, 1906.

[3] 'A revision of the American Papilios,' *Novitates Zool.*, XIII., pp. 431–752, 6 plates, 1906.

[4] 'Über die Zahl der Facetten in den zusammengesetzten Augen der Coleopteren,' Dissertation, Münster, 1905, pp. 64.

has had the patience to count the facets in the eyes of 150 species of beetles. He finds that the larger the specimen, the more numerous are the facets, and that usually there is not much difference in the sexes. The male in many cases, however, has more facets than the female. In *Lampyris splendidula* the male has 2,500 facets, while the female has but 300. *Melolontha vulgaris* has, male, 5,300, female, 4,850; and *Saperda carcharias*, male, 2,200, female, 1,800. There is no general reduction in nocturnal species.

South American termites are the subject of an exhaustive paper by Dr. N. Holmgren.[5] It is based on collections made in parts of Peru and Bolivia. Out of the thirty-nine species taken, twenty-six are described as new. He adopts the genera of Wasmann. Nearly one half of the article treats of the ethology and postembryonal development; the latter subject being almost entirely new. There are chapters on swarming, the founding of colonies, the enlargement of the nest, the use of the soldier, symbiosis of different species, classification by the nesting habits, and the geographical distribution of all the species known from South America.

Dr. K. Escherich describes some interesting new genera of exotic Thysanura,[6] the most remarkable being *Assmuthia*, with two new species from India. This genus bears much general resemblance to some Collembola, with nearly equal segments, a strongly convex body, and very short anal stylets. It occurs in ants' nests.

A. Dücke publishes a supplement to his former article on the habits of Brazilian social wasps.[7] The nests of nearly ninety species are now known to him. He gives a key to the genera of South American Vespidæ, and a classification by nests and habits. Photographs of nests are on four double plates.

Nathan Banks.

[5] 'Studien über südamerikanische Termiten,' *Zool. Jahrb., Abt. Syst.*, XXIII., pp. 521–676, 60 figs., 1906.

[6] 'Beiträge zur Kenntnis der Thysanuren,' *Zool. Anzeiger*, XXX., pp. 737–749, 1906.

[7] 'Sobre as Vespidas sociaes do Para—Supplemento,' *Bol. do Museu Goeldi*, IV., No. 4, 1906, pp. 652–698.

BOTANICAL NOTES.

'PROGRESS OF BOTANY.'

Under this alternative English title Doctor J. P. Lotsy, of Leiden, has begun the publication of an annual summary of the recent advances in botany to be known under its Latin title as 'Progressus Rei Botanicae' (Gustav Fischer, Jena, 18 mk.). Only the first Heft of 317 pages has come to hand, but the prospectus promises the completion of the first volume during the present winter. Hereafter it is the intention of the editor to publish the *Hefte* at intervals of about four months, the three *Hefte* making an annual volume of from six to eight hundred pages. The part before us contains four articles, viz.: 'Die Ontogenie der Zelle seit 1875,' by Professor Eduard Strasburger; 'The Present Position of Palaeozoic Botany,' by Doctor D. H. Scott; 'Bibliography of Literature on Palaeozoic Fossil Plants,' by E. A. Newell Arber, and 'Les progrès de la Géographie botanique depuis 1884,' by Professor Ch. Flahault. The treatment is considerably different in these papers. The first, by Strasburger, is an admirable summary of the steps by which our present knowledge of the process of cell division, and especially of karyokinesis, has been built up by additions made by many investigators. Dr. Scott's paper is an attempt to give a sketch of our present knowledge of paleozoic plants, and his treatment is somewhat more general than the preceding one. In Professor Flahault's paper the treatment is still more general, and is much more like a somewhat popular lecture on the subject to a company of botanists who were not specialists in phytogeography. It is an admirable introduction to the present development of this branch of Botany as understood by the author of the paper. The bibliographical paper by Mr. Arber is thoroughly classified, and must prove of great service to paleobotanists.

A full review of this promising publication, which must be indispensable to every botanist,

is reserved until the completion of the volume, which is promised within a few months.

VEGETATION PHOTOGRAPHS.

ATTENTION has already been called to the admirable reproductions of photographs of vegetation issued under the editorship of Professors Karsten and Schenck, and bearing the title of 'Vegetationsbilder.' The publication consists of quarto Heften, each containing six plates, and as there are eight Heften for each volume, it follows that the latter will contain forty-eight plates. Three volumes are already completed, and five Heften of the fourth volume have appeared. With each plate is a short descriptive text covering a page or two. The Heften which have appeared during 1906 include 'Vegetationsbilder aus Kleinasien,' by Emerich Zederbauer; 'Vegetationstypen von der Insel Koh Chang im Meerbusen von Siam,' by Johs. Schmidt; 'Ameisenpflanzen des Amazonasgebietes,' by E. Vle; 'Das südliche Togo,' by Walter Busse; 'Vegetationsbilder aus Feuerland, von den Falkland-Inseln und von Sudgeorgien,' by Carl Skottsberg; 'Westafrikanischen Nutzpflanzen,' by Walter Busse. The beauty of the photographs and the admirable manner of their reproduction merit the highest praise. They must constitute an indispensable addition to every botanical library.

SHORT NOTES.

SEVERAL months ago, H. A. Gleason published in the *Bulletin* of the New York Botanical Garden (Vol. 4, No. 13) 'A Revision of the North American Vernonieae' which should go far toward clearing up the confusion regarding the species of this tribe of Compositae. Seventeen genera are recognized, of which one—*Orthopappus*, a segregate of *Elephantopus*, is new. Of the 143 species here described, 99 are referred to the genus *Vernonia*, and of these, twenty-five are new to science. No less than ten of the genera are monotypic.—The genus *Ptelea*, represented in the northern states by the well-known hop-tree (*P. trifoliata*) expands wonderfully in the west and southwest, where, according to a recent monograph entitled 'The Genus *Ptelea* in the Western and Southwestern United States and Mexico' (Contrib. U. S. Nat. Herb., Vol. X.) by Dr. Edward L. Greene, there are fifty-nine species. In this paper, fifty-five of the species are described as new. It is noteworthy that in framing names for these species, the author has most commendably not found it necessary, excepting in one instance, to make use of the names of persons.—Botanists may now read an official account of the proceedings of the international botanical congress which took place in Vienna in 1905. A committee, consisting of Professors Wettstein and Wiesner, and Doctor Zahlbruckner, has issued a thick octavo pamphlet of 268 pages, entitled 'Verhandlungen des Internationalen Botanischen Kongresses in Wien, 1905' which gives the history of the movement which culminated in the congress, its personnel, the programs of the sessions, the discussions, etc., and the resulting 'International Rules of Botanical Nomenclature.' The latter are given in French, English and German. Along with the latter is given the list of generic names ('nomina conservanda') which are to be retained, the rule of priority to the contrary notwithstanding. The pamphlet may be obtained from the publisher (Gustav Fischer of Jena) for 12.50 Marks.—The same committee has issued a similar but somewhat larger (452 pages) pamphlet under the title of 'Résultats scientifiques du Congrès international de Botanique Vienne 1905.' It is edited by Dr. J. P. Lotsy, and is published also by Fischer (20 marks). It contains twenty-seven papers, mostly in German (one in English) which were presented during the scientific sessions of the Vienna Botanical Congress in 1905. The only paper by an American botanist is one by Professor Doctor Arthur on the structure, development and classification of the Uredineae.—A little book, issued three years ago by the same German publisher entitled 'Dendrologische Winterstudien' by C. K. Schneider, should be of much value to students of trees in these days when so many are fitting themselves for work in forestry. About sixty pages are given to the general organography of trees, including their general

form, arrangement of twigs, bark, lenticels, buds, etc., and this is followed by somewhat more than 160 pages describing the species of trees arranged according to winter characters. Following this is a systematic synopsis of the species, arranged in their appropriate families. A short bibliography and a full index complete the volume of nearly 300 small octavo pages. The work is very freely illustrated with drawings or half-tones of twigs, buds, hairs, sections of buds, twigs, bark and wood.

Charles E. Bessey.
The University of Nebraska.

SCIENTIFIC NOTES AND NEWS.

The American Association for the Advancement of Science and the national scientific societies affiliated with it are this week holding, in New York City, a meeting which promises to be one of the most important and largest gatherings of American men of science. Programs of the meetings have been printed here, and there is printed above the address of the retiring president of the association, Dr. C. M. Woodward, of Washington University. There will be published in the next and succeeding issues of Science full reports of the proceedings.

Professor J. A. Bownocker, of the State University, has been appointed state geologist of Ohio to succeed Professor Edward Orton, Jr., resigned.

M. Vidal de la Blache, professor of geography at the Sorbonne, has been elected a member of the Paris Academy of Sciences in the room of the late Albert Sorel.

Major Edgar A. Mearns, known for his important contributions to natural history, who has been chief surgeon of the department of Mindanao, has been relieved from duty in the Philippines and will proceed to the United States.

Dr. Alexander Graham Bell delivered an illustrated address before the Washington Academy of Sciences on December 13 'On Aerial Locomotion, with a few Notes of Progress in the Construction of an Aerodrome.' The address was discussed by Professor A. F. Zahm, of the Catholic University, Washington, D. C., and Mr. C. M. Manly, of New York City, formerly assistant to the late Secretary Langley.

Professor R. S. Chittenden, of Yale University, will deliver a series of lectures next spring before the faculty and students of the College of Science of the University of Illinois. The general subject of the lectures will be the physiology of nutrition.

On Monday evenings in February and March Professor Henry Edward Crampton, of Columbia University, will deliver a series of lectures upon 'The Doctrine of Evolution: its Basis and its Scope,' at Cooper Union.

The first public lecture of the winter will be delivered in the Academy of Medicine, New York City, on Saturday evening, December 29. The lecturer will be Dr. Wilfred T. Grenfell, C.M.G., physician to the missions of the Labrador coast, who will take for his subject, 'The Work of a Labrador Doctor.'

A magnetic survey of Mexico is now in progress under the joint auspices of the Mexican Government and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. The Mexican Government has two parties in the field under the direction of the Observatorio Astronomico Nacional Mexicano, Engineer Señor Abel Dias Covarrubias having charge of the eastern party and Señór Manuel Moreno y Anda being in charge of the western party, embracing the Pacific Coast from Manzanillo to Guaymas, inclusive of Lower California. The Carnegie Institution observer, Mr. J. P. Ault, will confine his operations to the part of Mexico north of the 25th parallel, upon the completion of which he will then proceed to Campeche, Yucatan and the Central American countries. The early completion of the general magnetic survey of Mexico being thus assured, it will be possible within the next year to construct accurate magnetic maps for the region between the parallels of latitude 20° and 49° North and meridians of longitude 65° and 125° West of Greenwich.

On the twenty-first of August last Professor Olof Hammarsten was sixty-five years

of age and in accordance with the laws of Sweden retired from the chair of physiological chemistry at the University of Upsala. A large volume, a 'Festschrift,' containing twenty-two papers on physiological and biochemical subjects had been prepared for the occasion by the friends and former pupils of Professor Hammarsten and the day was widely observed throughout the Scandinavian countries. Professor Hammarsten has been a teacher in the University of Upsala for thirty-seven years and his activity as an investigator dates from 1866. His most noted contributions deal with the coagulation of milk and of blood, with the chemistry of bile and the nature of mucin. Within each of these fields his keen observations and accurate descriptions serve as landmarks, the accuracy of which has never been successfully questioned.

AT its recent meeting in Mexico City the American Public Health Association elected the following officers: President, Dr. Domingo Orvañanos, Mexico; vice-presidents, Dr. Quitman Kohnke, New Orleans; Dr. R. M. Simpson, Winnipeg; Dr. G. T. Swartz, Providence; secretary, Dr. C. O. Probst, Columbus, Ohio; treasurer, Dr. Frank Wright, New Haven. Atlantic City, N. J., was selected as the place of meeting for 1907.

A TABLET has been placed in the rotunda of Memorial Hall, Yale University, to the memory of Elias Loomis, LL.D., who was professor of natural philosophy and astronomy in the college from 1860 to 1889, the year of his death. The tablet reads:—"In grateful remembrance of Elias Loomis, LL.D., who was graduated in 1830 from Yale College and twenty-nine years here served—1860–1889. An exact scholar, an astronomer of wide repute, in meteorology a pioneer, and a large benefactor of this university. This tablet is placed by a few of his old students to keep fresh the memory of the man and his teaching. 1906."

THE Cartwright prize of the Association of the Alumni of the College of Physicians and Surgeons of Columbia University will be awarded at commencement. This prize, which is of the value of $500, is open to general competition for an essay containing original investigations in the medical sciences. Further information can be obtained from Dr. H. E. Hale, secretary of the association, 752 West End Avenue, New York City.

THE University of Michigan has come into possession of a tract of land that with proper attention may be developed into a garden meeting all the requirements of the present-day European botanic gardens. This tract of land has been deeded by Dr. Walter H. Nichols, '91, and Mrs. Esther B. C. Nichols, '94. It comprises about thirty acres, and adjoins Forest Hill Cemetery on the east, having a frontage of about fifteen rods on Geddes Avenue. The land is separated from the Huron River by an approximately equal area owned by the city of Ann Arbor. By an agreement entered into by the regents of the university and the council of the city of Ann Arbor, the two pieces of land mentioned are to be developed as one, thus insuring a garden and park of at least sixty acres. This area will not make one of the largest gardens in the world, but it will make one of the large gardens of the world. It will be the same size as the St. Louis and Edinburgh gardens, nearly as large as the Paris garden, but much smaller than the New York garden, the Arnold Arboretum of Harvard University, the Kew gardens of England and the Buitenzorg garden maintained by Holland on the island of Java, each of which has over 200 acres of land, the last 1,100 acres. The following four aims for its use will be observed in the development of the garden: (1) teaching, in which students are instructed in the various orders and functions of plants; (2) scientific, in which genetic relationship is studied and experimental work is carried on; (3) economic, in which collections of medicinal and economic plants are made, and the effect of horticulture and agriculture is shown, and (4) esthetic and popularly educational, in which landscape effects are introduced and special provision is made to make the plantings, the drives and walks of interest and value to the public.

MEASURES have been taken by the Connecticut Academy of Arts and Sciences to affiliate

with Yale University. At a recent meeting it was voted that the academy was willing to enter into an agreement with Yale. The gist of the proposed agreement is that the university will pay to the academy the sum of $1,500 annually toward defraying the expenses of publishing the 'Transactions,' which will hereafter be issued under the title of 'Publications of Yale University.' The academy, on its part, will endeavor to increase its membership, and agrees to give adequate representation on its board of officers to the various departments of study in the university that may wish to avail themselves of the opportunity to publish scientific and literary papers.

THE American Public Health Association at its thirty-fourth annual meeting held this month in Mexico City, passed the following resolutions:

WHEREAS, A correct registration of births, marriages and deaths is necessary to indicate not only the natural increase of population, but also the measure of the health conditions and the effectiveness of sanitary operations in any country.

WHEREAS, With the increase in numbers, wealth and age of the populations of the several states and provinces, the necessity for evidence of births, marriages and deaths in cases of wills, pensions, insurance, crimes, etc., becomes daily of increasing urgency.

WHEREAS, Comparisons of the health conditions of different countries and districts and climates is only possible through the existence and study of such records.

WHEREAS, International comity and treaty stipulations not infrequently involve agreements touching the transmission of records relating to the births, marriages or deaths of individuals traveling or residing in foreign countries; and

WHEREAS, Such registration is imperfect or wholly wanting in some of the states of the countries registered in this Association, therefore, be it

Resolved, That the secretary of this association be instructed to transmit a copy of this resolution to the governors and boards of health of such states and provinces urging the desirability of effective legislation on this subject.

WHEREAS, The American Public Health Association is of the opinion, and has heretofore so expressed itself, that public health matters confronting the four countries embraced in this association can only be adequately administered by extending the powers and duties of their several chief executive and administrative health officers, and

WHEREAS, This association believes that such questions can only be satisfactorily dealt with by the establishment of a national department of health with a cabinet minister at its head in each country.

Therefore, this association, with a view to prosecute so desirable an end creates a committee consisting of three members from each of the four countries represented in the association and to be nominated by the president, the first-named member for each country to be chairman of that subcommittee and the chairman of the subcommittee of the United States to be its general chairman. This committee shall formulate what in the opinion of the Association should be the extent of the work, powers and duties of a national department of health and the subcommittee of any of the four countries shall take any steps deemed practicable by it to carry out the purpose of this resolution, and to this end be empowered to enlarge its committee as it may deem proper.

UNIVERSITY AND EDUCATIONAL NEWS.

COLUMBIA UNIVERSITY and Barnard College will receive $10,000 each under the will of Mrs. Annie P. Burgess. Dr. Daniel M. Burgess, her husband, will receive a life interest in the residuary estate, which will ultimately be divided into three equal parts, one of which will go to Columbia University, one to Barnard College, and the third to Hamilton College.

PLANS have been drawn for the new biological and geological building of Amherst College, made possible by a $75,000 gift from Mr. Andrew Carnegie, and an equivalent amount raised by alumni and friends.

A CLASS in general chemistry has been opened for women at Evening High School No. 73, on East Forty-sixth Street, between Second and Third Avenues, New York City. The class, which is conducted by Miss Rose Levy, is open every week-day evening except Friday and Saturday, from 7:30 to 9:30 o'clock, and is free to all who have had a public school education.

MR. A. G. TANSLEY, M.A., of Trinity College, Cambridge, assistant professor of botany at University College, London, and editor of the *New Phytologist*, has been appointed lecturer in botany in succession to Mr. A. C. Seward, who has succeeded the late Professor Marshall Ward in the chair of botany.